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Energy Demand Elasticity in Pakistan: An Inter-temporal Analysis from Household Survey Data of PIHS 2001-02 and PSLM 2010-11

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This study analyses household consumption patterns of different forms of energy in Pakistan over two survey rounds (2001-02 and 2010-11), while comparison with an earlier study based on 1984-85 data extends the analysis over a 25 years horizon. Income elasticities of different types of fuels have been computed using the Extended Linear Expenditure System. The analysis shows a differential pattern of energy use across the urban and rural areas of the country as well as changes over time, with rural households spending proportionately more on fuels throughout this period.

Keyword: Household Energy Consumption, Income Elasticity, Price Elasticity.

1. INTRODUCTION

Access to affordable and uninterrupted energy is a major pre-requisite for growth and development of any country. Being one of the main inputs to the industrial sector, availability of adequate energy directly affects the industrial output. At the household level, per capita energy consumption is an important determinant of household welfare, with expenditure on energy forming a significant share of total household consumption expenditure. Energy use has been stipulated to impact household welfare through a number of channels. In the context of households in a developing country using modern forms of energy such as Liquefied Petroleum Gas (LPG) for cooking purposes, Kanagawa and Nakata (2007) have identified four such mechanisms, which include education, health, income, and environment. Recent research by Barnes, *et al.* (2011) and Khandker, *et al.* (2012) has also investigated the effects of energy poverty on household welfare by examining the relationship between income-poverty and energy-poverty in India and Bangladesh, respectively.

In view of the importance of ensuring availability of cheap energy to their people, many developing countries, including Pakistan, have historically been subsidizing domestic fuel prices to ensure access to affordable energy. However, the fiscal burden of these subsidies has been becoming increasingly unsustainable for the governments, due to the global rise in fuel prices, especially since 2008, as a result of which prices are being gradually increased to move towards full cost recovery. Moreover, as the share of household spending on energy is likely to differ substantially across income levels, general subsidies provided across the board to all households may by regressive in nature and would serve to reduce access of low income population segments to modern energy sources. In order to better target and direct subsides towards the most

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disadvantaged social groups, it is important to understand "the structure of the correlations between energy and income levels" [Rodriguez-Oreggia and Yepez-Garcia (2014)]. In a recent World Bank study [Rama, *et al. (*2015)], it was found that energy subsidies disproportionately benefit the rich in South Asia, including Pakistan. In case of Pakistan, the poorest 40 percent (or first two income quintiles) households received less than 30 percent of the total electricity subsidies, while the richest 20 percent (or fifth income quintile) households got around 40 percent of the subsidies.

The fuel price rises are likely to have both income and substitution effects. In order to quantify the impact of these effects across different sectors of the economy, sector-specific demand elasticities of different fuels provide vital information for the policy makers. However, no recent estimates of demand elasticities at the household level are available for Pakistan. Burney and Akhtar (1990) estimated income and price elasticities of households' expenditure on different fuels using data from the 1984-85 Household Income and Expenditure Survey (HIES). These estimates are somewhat dated now and hold little policy relevance in today's environment, as energy prices have been continuously undergoing deregulation in the country since the 1990s.

The purpose of this study is to examine the inter-temporal pattern of household expenditure on energy consumption using data from Pakistan Integrated Household Survey (PIHS) 2001-02 and Pakistan Social and Living Standards Measurement Survey (PSLM) 2010-11. It computes the price and income elasticities using the Extended Linear Expenditure System methodology the one also employed by Burney and Akhtar (1990) so as to have a set of consistent estimates spanning over a period of 25 years. The use of micro data on household energy expenditures enables examination of the variations in the patterns of consumption of households with different socio-economic characteristics. The analysis of household patterns of energy consumption is carried out separately for the urban and rural areas of the country, as well as by expenditure quintiles. The income and price elasticities estimated using recent household survey data and the changes observed over the last decade can have direct relevance for energy pricing policy in Pakistan.

Rest of the paper is organized as follows. Section II discusses the trends in overall energy consumption in Pakistan over the last two decades, with special focus on the household sector. The theoretical framework and model used for estimation of income and price elasticities is presented in Section III. Section IV gives details of the household survey datasets used for empirical analysis, while Section V presents an examination of the patterns of household's energy expenditures. The analysis of income and price elasticities is presented in Section VI, while the final Section contains some concluding remarks and policy recommendations.

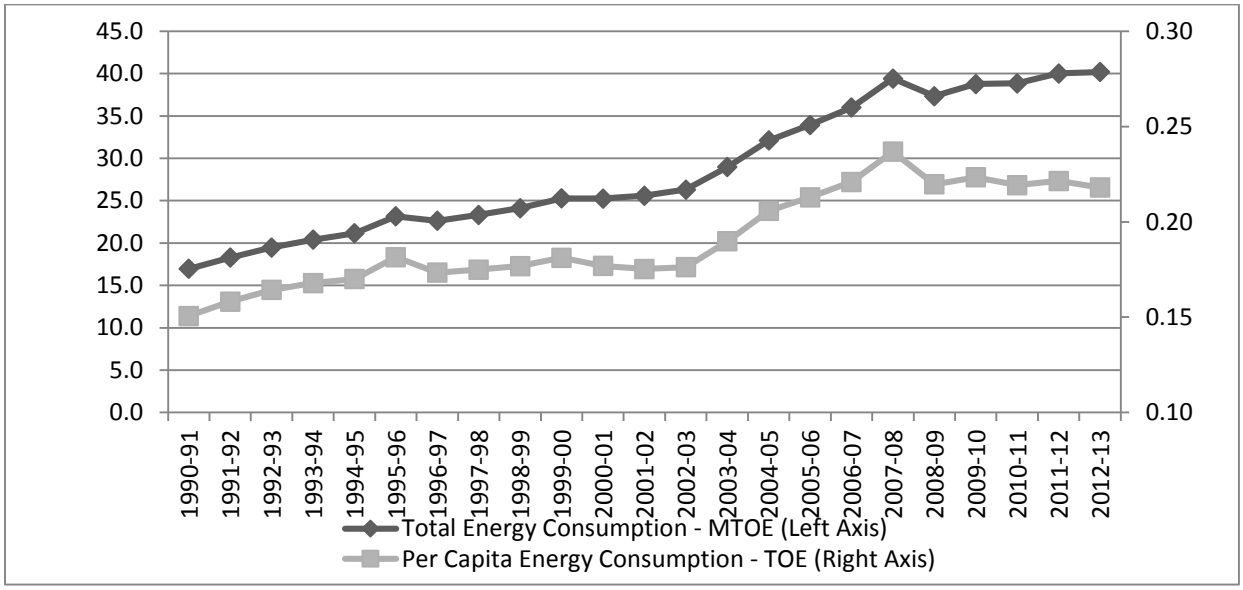
2. STYLIZED FACTS ABOUT ENERGY CONSUMPTION IN PAKISTAN

Commercial energy consumption in Pakistan has been steadily increasing from 1990 onwards[1]. It stood at 17 Million tonnes Oil Equivalent (MTOE) in 1990-91 but more than doubled

[1] Commercial energy consumption, which refers to use of commercial fuels that are traded in markets, does not include fuel sources, such as firewood and agricultural wastes commonly used in the rural areas of the country. According to some estimates, fuels such as biomass account for 36 percent of total energy consumption in the rural sector (Asif, 2009). Amur and Bhattacharya (1999)

to 40 MTOE in the last two decades (Figure 1), showing an annual average growth of 4 percent during this period[2]. In terms of per capita energy consumption, it increased from 0.15 tonnes Oil Equivalent (TOE) in 1990 to 0.22 TOE in the last two decades (Figure 1), exhibiting an average growth of 1.9 percent per annum. Despite witnessing reasonable growth over the last 23 years, Pakistan's per capita energy consumption levels are much lower than those of the developed nations, comparing unfavourably with the OECD average per capita energy consumption of 3.1 TOE. Per capita energy consumption level of Pakistan is also lower comparison to many of its developing country peers, like China (1.8 TOE), Thailand (1.6 TOE),
Iran (2.9 TOE) and India at 0.6 TOE (IEA, 2011).

Figure 1. Commercial Energy Consumption in Pakistan



Source: GoP (various issues).

The energy mix in the country has undergone significant changes over the last 23 years. In 1990-91, oil had the highest share in final energy consumption, accounting for 46 percent of the energy consumed, followed by natural gas at 31 percent (see, Table 1 and Figure 2). The share of oil peaked at 48.3 percent in 1995-96, which was offset by a decline in the share of electricity. In the post 1995-96 period, the share of oil witnessed a secular decline reaching as low as 28 percent in 2009-10, while the share of natural gas continued to rise, as a result of which, the shares of oil and natural gas in final energy consumption by 2012-13 have been reversed compared to their 1990-91 position (see, Table 1 and Figure 2).

Rising oil prices on the one hand and a relatively cheaper gas prices on the other contributed to the reversal of the shares of oil and gas during the post 1995-96 period. Notwithstanding this reversal, oil and natural gas combined have remained the predominant fuels in final energy consumption in Pakistan during the period under review, representing 76-79 percent of total energy

estimated total biomass consumption of 22.6 MTOE representing 44 percent of the primary energy needs of Pakistan, with the household sector accounting for 86 percent of total biomass consumption.

[2]Details of the data used for analysis in this section are provided in Appendix 1.

consumption. The share of electricity in total energy consumption has remained stable during the entire period under review at 15-16 percent, while the share of coal is observed to have initially declined up to 1999-2000 and has risen thereafter (see, Table 1 and Figure 2).

Table 1. Share of Different Sources of Energy in Total Commercial Energy Consumption

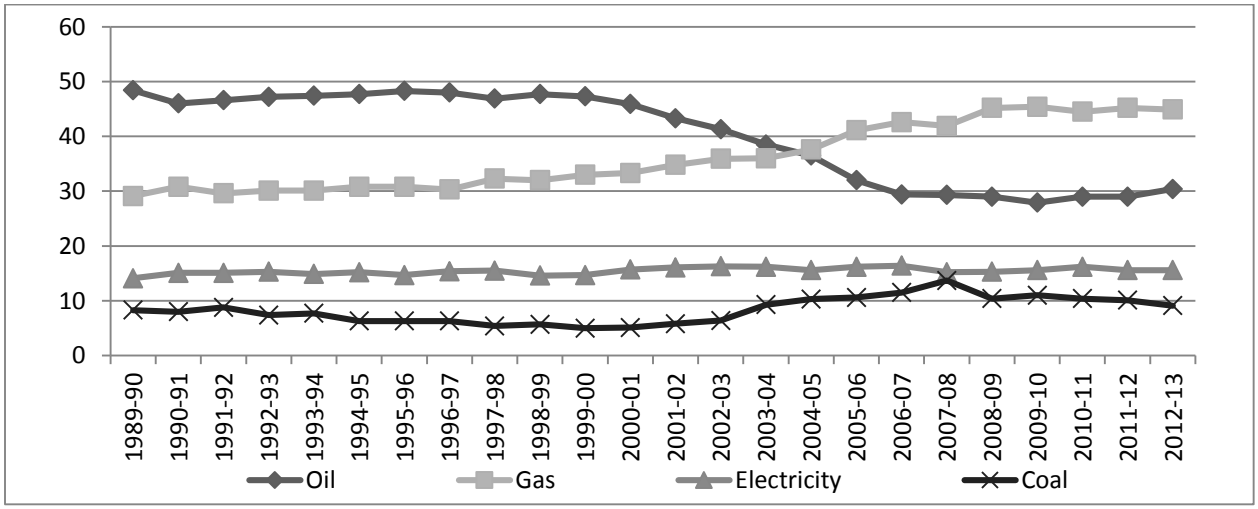
(Percent**)**

Year	Oil	Gas	Electricity	Coal
1990-91	46.0	30.8	15.1	8.0
1991-92	46.6	29.6	15.1	8.8
1992-93	47.2	30.1	15.3	7.4
1993-94	47.4	30.1	14.9	7.7
1994-95	47.7	30.8	15.2	6.3
1995-96	48.3	30.8	14.7	6.3
1996-97	48.0	30.3	15.4	6.3
1997-98	46.9	32.3	15.5	5.4
1998-99	47.7	32.0	14.6	5.7
1999-00	47.3	33.0	14.7	5.0
2000-01	45.9	33.3	15.7	5.1
2001-02	43.3	34.8	16.1	5.8
2002-03	41.3	35.9	16.3	6.4
2003-04	38.5	36.0	16.2	9.3
2004-05	36.5	37.6	15.6	10.3
2005-06	32.0	41.1	16.2	10.6
2006-07	29.4	42.6	16.4	11.5
2007-08	29.3	41.9	15.2	13.7
2008-09	29.0	45.2	15.3	10.4
2009-10	27.9	45.4	15.6	11.0
2010-11	29.0	44.5	16.2	10.4
2011-12	29.0	45.2	15.6	10.1
2012-13	30.4	44.9	15.6	9.1

Source: GoP (various issues).

Figure 2. Share of Different Sources of Energy in Total Commercial Energy Consumption

(Percent)



Source: GoP (various issues).

The share of different sectors in commercial energy consumption during the period under review is illustrated in Figure 3. The figure shows that the industrial sector has been the largest consumer of energy in Pakistan, followed by the transport and household sectors. It can be observed that the share of industrial sector in total commercial energy consumption peaked in 2006-07 reaching 44 percent of total energy consumption, when the economy as well as industry were experiencing high rates of growth. Correspondingly, the share of transport sector was at its lowest point at 27 percent as far as use of commercial energy is concerned. Subsequently, the share of industry started declining especially in the wake of the 2008 global oil price hike, while the share of transport rose correspondingly. It can further be seen that the share of household sector in commercial sector consumption has been witnessing a secular increase, especially in the post 2008 period, reaching a peak of 25 percent in 2012-13. The fall in share of industry and the corresponding rise in share of transport can be attributed to a number of factors. Firstly, the slowing down of industrial growth due to declining growth momentum of the economy reduced demand for energy. Secondly, the rising oil prices post 2008 led to substitution of petrol/ diesel for CNG in the transportation sector, increasing energy demand in this sector. It is also pertinent to point out that energy supply, particularly of electricity, to the industrial sector has been rationed in recent years due to the power shortages being experienced by the country[3].

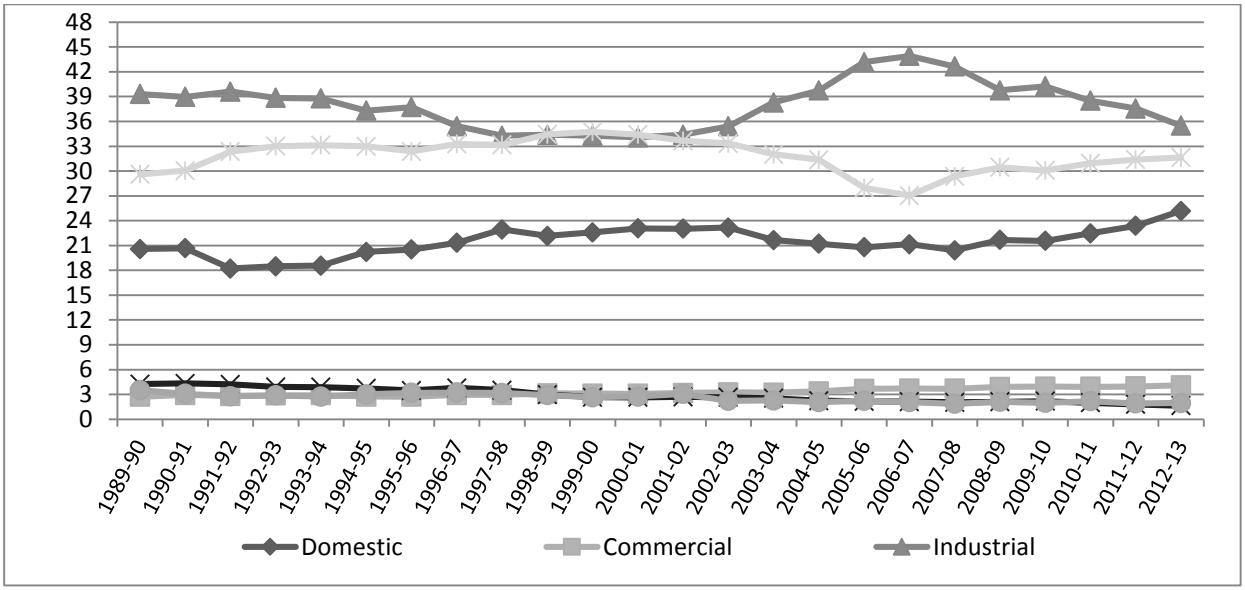
Table 2. Households Commercial Energy Consumption

Year	HH Energy Consumption (MTOE)	HH Energy Consumption (% of Total Energy Consumption)
1990-91	3.5	20.66
1991-92	3.3	18.22
1992-93	3.6	18.47
1993-94	3.8	18.58
1994-95	4.3	20.23
1995-96	4.7	20.51
1996-97	4.8	21.32
1997-98	5.4	22.94
1998-99	5.3	22.16
1999-00	5.7	22.58
2000-01	5.8	23.07
2001-02	5.9	23.03
2002-03	6.1	23.16
2003-04	6.3	21.67
2004-05	6.8	21.22
2005-06	7.1	20.78
2006-07	7.6	21.12
2007-08	8.0	20.42
2008-09	8.1	21.67
2009-10	8.4	21.56
2010-11	8.7	22.46
2011-12	9.4	23.39
2012-13	10.1	25.18

Source: GoP (various issues).

[3] A detailed analysis of the factors responsible for the fall in share of industry and rise in share of transport is beyond the scope of this paper.

Figure 3. Share of Different Sectors in Total Commercial Energy Consumption (%)



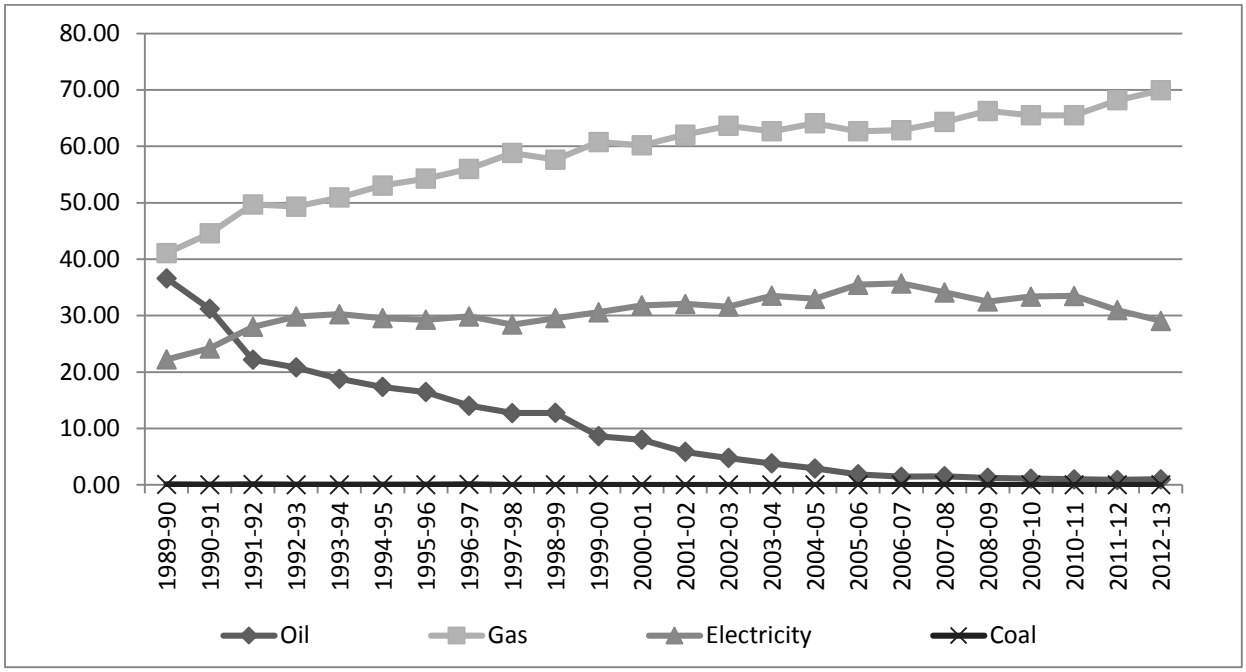
Source: GoP (various issues).

Trends in households' use of commercial energy during the period 1990-2012, as presented in Table 2 and Figure 3, show that the household sector consumed 3.5 MTOE (20.7 percent) of energy in 1990-91 from the total energy consumption of around 17 MTOE, which increased to 10 MTOE (25.2 percent) in 2012-13. Households' use of commercial energy has grown at a faster pace than the per annum growth in total energy consumption (5.1 percent *vs.* 4 percent) during the period under review, resulting in rising share of household sector in commercial energy consumption as indicated in the preceding analysis.

The analysis of household energy use by source shows large inter-fuel substitution during the period, with the share of oil declining consistently from a significant 31 percent of total household energy use in 1990-91 to a negligible 1 percent by 2012-13 (see, Figure 4). This decline has been matched by a sharp increase in the share of natural gas from 44.6 percent to 70 percent an increase of 25.4 percentage points. The share of electricity on the other hand, witnessed an increase of only 4.9 percentage points during the same period. Currently, natural gas is the predominant source of commercial energy being consumed by the household sector, accounting for around 70 percent of total household energy use in 2012-13. The share of coal in household energy use has been almost nil during the period under review.

The preceding analysis of energy consumption in the country highlights that per capita commercial energy consumption has increased steadily since the 1990s with the growth being higher for the household sector, reflecting improving living standards. Moreover, the share of the household sector in total commercial energy consumption has also risen during the period. This period has also seen a rising trend in fuel prices faced by the household sector, as the government has been compelled to gradually reduce subsidies provided to the domestic sector on commercial fuels due to mounting fiscal pressures. These developments are an important motivation for the present study, which seeks to carry out an in-depth assessment of patterns of household spending on fuels and the changes observed over time.

Figure 4: Share of Different Sources of Energy in Household Energy Consumption (%)



Source: GoP (various issues).

3. THEORETICAL FRAMEWORK

The study estimates an Extended Linear Expenditure System (ELES), which was first formulated by Lluch (1973) and used by Burney and Akhtar (1990) to analyse households' consumption patterns of different fuels in Pakistan using 1984-85 micro level data. In comparison with its predecessor the Linear Expenditure System (LES), the ELES gives better estimates of price elasticities[4]. Moreover, the ELES permits measurement of the impact of relative prices on household savings through endogenising the total household consumption expenditure.

It is pertinent to point out that there are better and more flexible demand systems available for analysing household consumption decisions. In this regard, the Almost Ideal Demand System (AIDS) given by Deaton and Muellbauer (1980a) is preferable to the ELES as the utility function underlying this system assumes additive preferences, implying that the marginal utility of one good is independent of the quantity of other goods consumed. This has been shown to be not a very plausible assumption, in the case of food commodities [Alderrman (1988)]. However, the application of AIDS requires data on prices of the commodities under examination, which are not available for different fuels from the PIHS/ PSLM datasets[5]. In view of this data constraint, the ELES has been used for analysis as it permits estimation of price elasticities in the absence of price data.

The ELES is based on the standard constrained utility maximization problem of how

[4] See Lluch, *et al.* (1977) for details.
[5] For details, see Appendix 3.

much to spend on various goods, given a fixed budget per unit of time[6]. The household expenditure behaviour can be expressed by the following relationship, which assumes that spending decisions are made on a per capita basis, and that with the exception of income and prices all other socio-economic factors like age, education and gender do not influence consumption;

$$e_i = p_i x_i = p_i r_i + \beta_i (y - \sum p_i r_i) \quad \ldots (1)$$

where, $i = 1, 2, \ldots, n$ 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, while (r_i, β_i) are the parameters to be estimated. The βi's show the marginal propensity to consume of good i with $\sum \beta_i = \mu$ is the overall marginal propensity to consume. The parameter r_i represents the basic needs or subsistence quantity of good i if it is positive, while $\sum p_j r_j$ indicates total subsistence expenditure. The expression (y - $\sum p_j r_j$) denotes supernumerary income. The relationship shown by Equation (1) is referred to as the ELES.[7]When the expenditure equations for all goods are added up, an aggregate consumption function of the following form is obtained:

$$E = (1 - \mu) \sum p_i r_i + \mu y \quad \ldots (2)$$

where, E is the total household consumption expenditure. Equation (2) enables identification of $\sum p_i r_i$ in the absence of price data which helps in obtaining price elacticities from the cross-section data.

As r_i appears in all the equations, the system of equations described by Equation (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 $p_i r_i$ is independent of the unit of observations. Thus, it can be replaced by r_i*. This stochastic specification of the ELES can then be written as:

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

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

The system of equations as 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. The maximum likelihood

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

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

With $x_i > -r_i$, $\beta_i > 0$, and $\sum \beta_i = \mu$.

[7] 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-$\sum p_j r_j$) referred to as supernumerary expenditure. The coefficient of (E-$\sum p_j r_j$) denoted say as β_i^* is interpreted as marginal budget shares, i.e., marginal propensity to consume out of total expenditure, such that $\sum \beta_i^* = 1$. The β_i^* can be obtained from β_i^* as $\beta_i^* = \beta_i / \mu$.

estimates of μ, r_i* and $\sum r_i$* can be estimated from the OLS estimates of α_i and β_i using the following relationship:

$$\mu = \sum \beta_i$$
$$\sum r_i^* = \sum a_i/(1 - \mu)$$
$$r_i^* = a_i + \beta \sum r_i^*$$

The relevant demand elasticities can then be computed as follows:

(i)	Income Elasticity of Good *i*:	η_{iy}	=	$\beta_i(y/e_i)$
(ii)	Own-price Elasticity of Good *i*:	η_{ii}	=	$(1 - \beta)_i) (r_i^*/e_i) - 1$
(iii)	Cross-price Elasticity of Good *i*:	η_{ij}	=	$-\beta_i(r_j^*/e_i)$
(iv)	Income Elasticity of Total Expenditure:	η_{Ey}	=	$\mu(y/E)$

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 r_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.

4. DATA

This study is based on the micro level data of the Pakistan Integrated Household Survey (PIHS) 2001-02 and Pakistan Social and Living Standards Measurement (PSLM) Survey 2010-11, compiled by the Pakistan Bureau of Statistics. The data from PIHS 2001-02 are based on a nationally representative sample of 14,676 households, out of which 5,514 (37.6 percent) households were residing in the urban areas, while 9,162 (62.4 percent) were resident of the rural areas of the country[8]. The PSLM 2010-11 data are also based on a nationally representative sample of 16,313 households, with 6,572 households (40.3 percent) living in urban areas and 9,741 (59.7 percent) residing in rural areas[9]. The household income and expenditure module of both survey rounds is compatible with each other, reporting expenditures on the same range of commodities and can thus be used for inter-temporal comparison.

Total household expenditure, comprising of expenses on both durable and non-durable goods as well as services, has been categorized into two broad groups – fuel and non-fuel expenditures. The expenditure on fuels has been further disaggregated into expenditures on different types of fuel – firewood, kerosene oil, natural gas, electricity, and other-fuels[10]. The other

[8] The definitions of urban and rural areas adopted in both survey rounds, i.e., PIHS 2001-02 and PSLM 2010-11 is given in Appendix 2.

[9] The sample from both survey rounds excludes households for which the reported total consumption expenditure was zero or missing.

[10] Both the surveys do not include price and quantity information on main fuel types – piped gas and electricity, which precludes analysis in terms of actual household energy consumption. Thus, expenditure on energy is used as a proxy for energy use.

fuels category includes household expenses on coal and other biomass fuels such as dung cakes and crop residue, which are important sources of energy, especially for the rural households[11].

5. TRENDS IN HOUSEHOLD ENERGY CONSUMPTION

The overall picture of households' expenditures on different fuels during 2001-02 and 2010-11 is presented in Table 3[12]. The data show that a large proportion of urban households reported having zero expenditure on kerosene oil, other fuels and firewood, with this proportion rising between 2002-11. Electricity, followed by natural gas is seen to be the dominant fuel used by urban households with access to both these fuel types rising between 2001-02 and 2010-11. On the other hand, in the rural areas, majority of households are seen to have zero expenses on natural gas in both the years under review, owing to lack of access to gas in rural areas, with this share declining in 2010-11. The main fuel types utilized in the rural areas include firewood and electricity, with the share of households reporting zero expenses on electricity declining sharply between 2002 and 2011, implying increasing access to electricity by rural households due to the village electrification programme pursued by the government, on the one hand and inflow of remittances increasing the demand for electrical appliances on the other[13].

The analysis of the average monthly expenditure and expenditure shares of different fuels, using constant prices of 2001-02 shows that the rural households spent proportionately more on fuels compared to the urban households during both 2001-02 and 2010-11, but more so in 2010-11 (Table 3)[14]. This finding is consistent with that of Burney and Akhtar (1990), who attributed the higher average spending of rural households to the lower oil equivalent energy provided by firewood and other-biomass fuels used mainly by the rural households in comparison to electricity and natural gas. This implies that for a given amount of oil equivalent of energy, rural households have to spend a higher amount on purchase of fuels in comparison to their urban counterparts.

Real expenditures on fuel increased only marginally for the urban households during the period 2001-02 to 2010-11, from Rs.678 per month to Rs.688 per month (Table 3), showing an annual average growth of just 0.2 percent per annum. In comparison, non-fuel expenditures of urban households grew at a higher rate of 1.4 percent per annum during the same period. On the other hand, real expenditures of rural households increased at a faster pace on both fuels (2.8 percent) and non-fuels (2.6 percent).

The expenditure share of urban households on fuels declined slightly from 7.3 percent in 2001-02 to 6.6 percent in 2010-11, while in case of rural households it increased marginally (Table 3). A comparison with the earlier estimates by Burney and Akhtar (1990) based on 1984-85 data

[11] Details of the household energy expenditures included in both the surveys are presented in Appendix 3.

[12] It is pertinent to point out here that the household use of energy obtained from the survey datasets includes both commercial and non-commercial energy consumed during the reference period, i.e., one month. Therefore, estimates of commercial energy consumption for the domestic sector as discussed in section II are not directly comparable with the estimates of household energy use obtained from the survey datasets as they exclude non-commercial sources, which are likely to higher in rural areas of the country. See, footnote 1 for further details.

[13] The share of households using electricity in the rural areas increased at a faster rate between 1984-2001, i.e., more than doubling from 30 percent in 1984-85 as indicated by Burney and Akhtar (1990) to 65.8 percent in 2001-02.

[14] The analysis by nominal prices is presented in Appendix Table 1.

reveals that the average household expenditure share on fuels was much lower at 4.9 percent and 5.9 percent, in the urban and rural areas, respectively. The increase in the household budget share on fuels over the period 1984-2001 can be attributed to both increases in fuel prices and greater access as well as higher utilization of energy on account of more widespread use of household appliances owing to the rise in income levels over the years. The higher use of household appliances over time is supported by Khan and Khalid (2010) who found that expenditure share on durable goods increased between 1984-85 and 2000-01 for both urban and rural households, with the increase being higher for rural households (2.5 times)[15].

Within the fuel category, urban households had highest expenditure shares on electricity followed by natural gas, while their rural counterparts spent proportionately more on electricity and firewood, during both the years under review. The expenditure share of natural gas in the urban sector declined during 2002-11, while share of electricity increased marginally. This fall in expenditure share of natural gas in urban areas may be driven by the fall in average size of urban households[16] resulting in lower use of gas for cooking purposes as well as better efficiency overtime of appliances using natural gas. In the rural areas, the expenditure shares of both electricity and firewood increased as well but more so on electricity during the same period (Table 3). Comparison of these results with the earlier estimates by Burney and Akhtar (1990) show that the increase in average expenditure shares on fuels during the period 1984-2001 was driven by higher budgetary outlays on electricity, which went up by 2.8 times for urban households and a substantial 5.6 times for rural households. This lends further support to the premise that the increase in expenditure shares on fuels during 1984-2001 was driven mainly by higher demand for electricity stemming from greater use of household appliances by both urban and rural households across the country. The increase in fuel expenditure share of rural household over the period 2002-11 is also driven mainly by higher expenditures on electricity due to more widespread use of electrical appliances.

In per capita terms, the average real household expenditure on both fuels and non-fuels increased at a higher annual rate in the rural areas as compared to the urban areas during the period 2002-11 (2.5 percent and 1.8 percent *vs.* 3.6 percent and 3.5 percent, respectively)[17]. Urban households' recorded highest per capita expenditures on electricity and natural gas in both 2001-02 and 2010-11, with expenditure on electricity increasing by 1.9 percent, while those on natural gas declining by 1.3 percent per year during this period. Per capita spending of rural households on electricity and firewood was highest during both the years, with expenditures on electricity increasing by a higher annual rate between 2001-02 and 2010-11 compared to firewood (5.0 percent *vs.* 3.4 percent (Table 3).

[15] The durable goods category includes expenditures on household appliances, such as refrigerators, freezers, electric fans, air coolers, air conditioners, etc.
[16] The average household size fell from 6.9 in 2001-02 to 6.2 in 2010-11.
[17] The analysis by nominal per capita expenditures is presented in Appendix Table 1.

Table 3. Households' Expenditure on Different Fuels

Year	Households with zero reported expenditures (% of total HHs)		Average household expenditure (Rs. per month)		Average household expenditure (% of total household expenditure)		Average household expenditure per capita (Rs. per month)	
2001-02	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Firewood	69.71	21.87	63.52	160.98	0.68	2.67	9.38	24.9
Kerosene oil	82.14	45.56	13.7	26.65	0.15	0.44	2.43	4.62
Natural gas	31.01	87.4	171.89	23.87	1.84	0.4	29.84	3.92
Electricity	4.99	34.16	412.49	160.74	4.42	2.67	72.78	25.4
Other Fuels	87.03	47.82	16.39	70.59	0.18	1.17	2.47	11.48
Total Fuel			677.99	442.82	7.26	7.35	116.91	70.3
Total Non-Fuel			8,663.4	5,580.5	92.74	92.65	1,476.3	847.1
2010-11	In 2001-02 prices (General CPI)							
Firewood	79.43	30.76	56.53	197.89	0.54	2.66	9.04	32.50
Kerosene oil	95.75	78.14	2.24	14.41	0.02	0.19	0.36	2.43
Natural gas	20.22	81.02	147.18	40.30	1.41	0.54	26.23	6.98
Electricity	1.08	14.68	470.53	218.00	4.51	2.93	84.92	36.93
Other Fuels	91.92	51.46	11.58	82.43	0.11	1.11	1.93	14.05
Total Fuel			688.1	553.03	6.59	7.42	122.48	92.89
Total Non-Fuel			9,751.9	6,896.7	93.41	92.58	1,714.11	1,111.19

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

Table 4 presents the average real monthly household expenditure (total and fuel) and income in per capita terms for the sample of urban and rural households during 2001-02 and 2010-11 by expenditure quintiles[18]. The per capita household income is higher than the per capita household expenditure across all expenditure quintiles in both 2001-02 and 2010-11 except for the first quintile in 2010-11 in the rural areas[19]. The highest growth in real per capita household monthly income during the period 2002-11 for urban households is observed in the fourth quintile, followed by the fifth and third quintiles, with growth being lowest for households in first quintile. In case of rural households, the highest growth in real per capita income is seen for households in the fifth quintile, followed by those in the second and fourth quintiles, with growth being lowest for households in the first quintile. Such findings suggest worsening of income inequality between the richest and poorest segments of society.

[18] Average monthly household expenditures by quintile in nominal terms are shown in Appendix Table 2.

[19] Income not spent is savings. The average per capita household savings for the periods 2001-02 and 2010-11 reveals interesting facts. The average per capita household savings declined substantially in urban areas for the first two quintiles and increased equally strongly for the third, fourth and fifth quintiles, more so for the fifth quintile during 2002-11. In the rural areas, the average per capita household savings declined substantially for the first quintile but exhibited a continuous rise with second quintile onwards, more so for the fifth quintile. It can be deduced from the findings that the economic well-being of the poorer segments of households (first and second quintile) have deteriorated and that income disparity between the poorest households and the richest one has widened during the two sample period. A word of caution is essential here as household income is generally under-reported in household surveys, as people are reluctant to provide true income in fear of taxation. It is beyond the scope of the present study to dwell more on this issue.

Per capita real expenditure on fuels is seen to rise with income across all expenditure quintiles, with the exception of second and third quintile in urban areas and second quintile in rural areas during both the sample years[20]. Average annual growth in real per capita expenditure on fuels during the period 2002-11 is observed to be negative for urban households in the first and second quintiles, while being highest for households in the fifth quintile. Growth in real per capita expenditure on fuels is seen to be higher for rural households across all quintiles in comparison to urban households, with rural households witnessing highest growth in the second and third expenditure quintiles (Table 4). This growth in per capita expenditures on fuels in rural areas is likely to be driven by the higher demand for household appliances due to rising income levels of rural households. Recent years have seen a higher flow of resources to the rural areas, as a result of rising farm support prices, as well as increasing flows of foreign and domestic remittances [for more on this, see Khan and Khalid, 2010].

Table 4. Average per Capita Real Household Expenditure and Income by Expenditure Quintiles

Expenditure quintiles	Average per capita total household monthly expenditure (Rs.)		Average per capita household monthly income (Rs.)		Average per capita monthly expenditure on fuel (Rs.)	
2001-02	Urban	Rural	Urban	Rural	Urban	Rural
First	894.30	746.32	1,013.57	828.63	91.86	67.66
Second	958.90	780.07	1,032.14	795.06	90.15	62.23
Third	1,067.83	875.67	1,175.71	897.99	89.83	65.58
Fourth	1,239.99	1,024.43	1,340.72	1,046.39	98.54	75.32
Fifth	2,649.61	1,449.76	3,090.78	1,508.00	165.18	92.20
2010-11	In 2001-02 Prices – General CPI				In 2001-02 Prices – fuel & lighting CPI	
First	1,044.18	959.11	1,063.39	955.68	90.11	85.34
Second	1,155.05	1,013.33	1,163.32	1,048.56	87.44	83.43
Third	1,297.87	1,138.08	1,456.29	1,165.92	90.71	87.76
Fourth	1,576.17	1,299.53	1,708.91	1,365.25	106.07	92.13
Fifth	3,119.97	1,930.42	3,865.11	2,302.67	184.52	121.66
Average annual growth rate, 2002-11 (%)						
First	1.86	3.17	0.55	1.70	-0.21	2.90
Second	2.27	3.32	1.41	3.54	-0.33	3.79
Third	2.39	3.33	2.65	3.32	0.11	3.76
Fourth	3.01	2.98	3.05	3.39	0.85	2.48
Fifth	1.97	3.68	2.78	5.86	1.30	3.55

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

The disaggregation of real per capita fuel expenditure by type of fuels given in Table 5 shows that per capita expenditures on electricity and natural gas, by and large, increased across each expenditure quintile for both urban and rural households. Real per capita expenditures on kerosene oil and other fuels, on the other hand are observed to generally decline across the five

[20] Appendix Table 3 shows the quintile-wise per capita expenditures on different fuels in nominal terms.

quintiles for urban and rural households during both the years under review, with few exceptions. These include rising real per capita expenditures on kerosene oil across the fourth and fifth rural expenditure quintiles in 2001-02 and the fifth expenditures quintile for other fuels in case of rural households during both the years reviewed. In case of firewood, real per capita expenditures go down across quintiles in the urban sector, while they increase for the rural households indicating that firewood is an inferior energy form for urban households, while being a normal fuel type for the rural households, owing to the lack of widespread availability of natural gas in rural areas.

Table 5. Average per Capita Real Household Expenditure by Fuel Type and Expenditure Quintile

Expend Quintiles	Firewood		Kerosene oil		Natural gas		Electricity		Other fuels	
2001-02	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
First	16.60	23.05	4.29	4.63	19.37	1.47	44.51	22.15	7.08	16.36
Second	13.21	23.09	3.70	4.31	19.74	2.60	50.10	20.75	3.40	11.48
Third	11.14	25.23	2.75	4.29	24.14	3.70	49.13	23.23	2.66	9.15
Fourth	7.93	27.90	2.18	4.73	28.38	5.97	58.35	28.10	1.70	8.61
Fifth	5.42	27.29	1.25	5.62	41.95	8.90	115.55	40.81	1.01	9.58
2010-11	In 2001-02 Prices									
First	18.95	31.73	0.75	3.00	17.29	2.65	48.16	30.27	4.96	17.69
Second	12.43	31.90	0.39	2.45	18.66	4.45	53.23	30.86	2.73	13.78
Third	9.68	31.58	0.39	2.40	20.81	6.35	58.07	35.25	1.75	12.18
Fourth	6.32	32.95	0.28	2.08	25.33	8.11	72.77	37.38	1.37	11.62
Fifth	4.29	32.62	0.20	1.68	37.42	17.73	141.93	57.21	0.69	12.41
	Average annual growth rate, 2002-11 (%)									
First	1.57	4.18	-9.17	-3.91	-1.19	8.92	0.91	4.07	-3.33	0.90
Second	-0.66	4.24	-9.94	-4.80	-0.61	7.91	0.69	5.41	-2.19	2.23
Third	-1.46	2.80	-9.54	-4.90	-1.53	7.96	2.02	5.75	-3.80	3.68
Fourth	-2.26	2.01	-9.68	-6.23	-1.19	3.98	2.75	3.67	-2.16	3.88
Fifth	-2.32	2.17	-9.33	-7.79	-1.20	11.02	2.54	4.47	-3.52	3.28

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

In terms of annual growth in per capita expenditures on different fuel types between the period 2001-02 and 2010-11, the analysis shows that negative growth is recorded in real per capita expenditures on firewood for urban households across the second to fifth expenditure quintile. Real per capita expenditures for kerosene oil are observed to decline for both urban and rural households across all quintiles, with the fall being higher for urban households in each quintile. Real per capita expenditures are also seen to fall for urban households in case of natural gas and other fuels. On the other hand, real per capita expenditures of rural households on natural gas witness highest growth in comparison to the other fuel types across all expenditure quintiles owing to the government's policy of providing affordable access to natural gas to the rural population as much as possible, with households in the fifth quintile showing an average annual growth of 11 percent during 2002-11 (Table 5).

The analysis in Table 6 shows that the share of fuel in average household real monthly expenditure declines for both the urban and rural households across all expenditure quintiles, during both 2001-02 and 2010-11 periods[21]. This finding may indicate that all fuel types are necessities as the Engel's Law stipulates that the share of expenditure on necessities declines with rise in total income/ expenditure. In addition, it can be seen that in 2001-02, the urban households allocated a larger proportion of their total expenditure to fuel compared to their rural counterparts across all expenditure quintiles, except the top one. On the other hand, in 2010-11, rural households are observed to have a higher share of expenditures on fuel in comparison to urban households, across all expenditure levels owing to the government's policy of rural electrification as well as providing access to natural gas to the rural households, as much as possible.

Table 6. Pattern of Household Real Expenditure and Income by Expenditure Quintile

Expenditure quintiles 2001-02	Average household monthly expenditure (Rs.)		Average household monthly income (Rs.)		Share of fuel in household monthly expenditure (%)	
	Urban	Rural	Urban	Rural	Urban	Rural
First	2,949.22	2,906.34	3,259.55	3,136.27	10.39	9.09
Second	4,455.27	4,412.42	4,623.06	4,436.89	9.50	7.97
Third	5,830.82	5,785.74	6,225.01	5,934.80	8.73	7.42
Fourth	7,814.36	7,742.77	8,454.58	7,887.57	8.05	7.22
Fifth	16,643.90	13,458.73	19,080.88	14,030.61	6.25	6.26
2010-11	In 2001-02 Prices					
First	3,738.25	3,608.92	3,768.66	3,520.48	8.62	8.77
Second	5,428.90	5,380.84	5,338.72	5,404.61	7.57	8.09
Third	7,084.97	7,062.91	7,832.84	7,169.32	7.05	7.59
Fourth	9,443.31	9,361.95	10,009.32	9,667.83	6.62	7.04
Fifth	19,114.55	15,864.08	23,254.48	18,555.39	5.98	6.36

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

The breakup of the share of household monthly expenditure on fuels by different fuel types shown in Table 7 reveals the differential patterns of spending by households across the consumption expenditure distribution. The expenditure share of firewood, kerosene oil and other fuels declines across each successively higher expenditure quintile for both urban and rural households in both the years. In case of natural gas, during both 2001-02 and 2010-11, the budget share of rural households rises across the expenditure quintiles owing to higher availability of natural gas as a result of government policy. The expenditure share of urban households on natural gas increases persistently upto the fourth quintile and then drops sharply for the top quintile. It is a possibility that the richest quintile households in urban areas may be substituting natural gas with electricity for heating and cooking purposes.

6. RESULTS AND ANALYSIS

The estimated income and price elasticities of household spending on different fuels are analysed and discussed in this section. The results of the regression model given in Equation (3)

[21] This analysis in nominal terms is given in Appendix Table 4.

are presented in Table 8 for both the urban and rural areas for the periods 2001-02 and 2010-11. The coefficients are highly significant statistically during both the years under consideration; and with the exception of kerosene oil and other fuels in the urban areas for 2001-02 and firewood, kerosene oil and other fuels for urban households in 2010-11, have the anticipated signs.

Table 7. Share of Different Fuels in Total Real Household Expenditure (%)

Expenditure quintiles 2001-02	Firewood		Kerosene oil		Natural gas		Electricity		Other fuels	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
First	2.03	3.08	0.44	0.58	1.80	0.16	5.03	2.87	1.09	2.39
Second	1.71	2.99	0.40	0.54	1.90	0.25	5.01	2.62	0.47	1.57
Third	1.28	2.89	0.27	0.46	2.20	0.37	4.67	2.61	0.32	1.09
Fourth	0.80	2.79	0.19	0.45	2.23	0.47	4.64	2.63	0.18	0.88
Fifth	0.32	2.05	0.06	0.31	1.63	0.54	4.18	2.68	0.06	0.68
2010-11										
First	2.02	3.30	0.08	0.32	1.45	0.24	4.49	3.02	0.58	1.90
Second	1.27	3.14	0.04	0.25	1.50	0.35	4.50	2.92	0.26	1.43
Third	0.90	2.84	0.03	0.22	1.55	0.47	4.40	2.96	0.16	1.11
Fourth	0.50	2.62	0.02	0.17	1.57	0.53	4.41	2.81	0.11	0.91
Fifth	0.22	1.91	0.01	0.10	1.26	0.81	4.46	2.83	0.03	0.71

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

Table 8. Results of OLS Regression

Fuel	2001-02				2010-11			
	Urban		Rural		Urban		Rural	
	α	β	α	β	α	β	α	β
Firewood	7.948	0.001	22.710	0.002	24.064	-0.001	70.224	0.002
	(23.18)*	(7.86)*	(65.80)*	(11.45)*	(31.30)	(-6.98)*	(59.61)*	(8.74)*
Kerosene oil	2.561	0.000	4.293	0.000	0.964	0.000	5.717	0.000
	(14.00)*	(-1.37)	(12.99)*	(1.81)*	(12.33)*	(-2.99)*	(29.06)*	(0.08)
Natural gas	19.784	0.006	2.318	0.002	47.479	0.003	3.875	0.004
	(31.14)*	(29.51)*	(11.85)*	(14.62)*	(38.90)*	(23.28)*	(5.66)*	(29.15)*
Electricity	27.073	0.025	19.715	0.006	123.616	0.015	54.507	0.011
	(16.47)*	(52.06)*	(42.58)*	(21.98)*	(31.95)*	(39.12)*	(41.96)*	(39.97)*
Other Fuels	2.896	0.000	10.951	0.001	5.181	0.000	31.359	0.001
	(18.75)*	(-5.12)*	(44.06)*	(3.86)*	(17.24)*	(-4.15)*	(44.91)*	(4.00)*
Total Fuel	60.262	0.031	59.988	0.011	201.305	0.018	165.682	0.018
	(32.63)*	(57.38)*	(81.19)*	(25.10)*	(47.10)*	(40.46)*	(85.20)*	(43.69)*
Total Non-Fuel	584.338	0.494	703.693	0.150	2537.072	0.301	1702.721	0.302
	(34.11)*	(97.44)*	(114.05)*	(41.76)*	(58.38)*	(68.34)*	(95.39)*	(81.27)*

Note: Figures in parentheses are t-statistics.

* Denotes coefficient as statistically significant at the traditional level of significance, i.e., 5 percent.

The negative coefficients of income for kerosene oil and other fuels for the urban households in 2001-02 indicate that urban households considered them as inferior goods. The analysis further reveals that even after ten years (2010-11), firewood, kerosene oil and other fuels

remained an inferior fuel for urban households. The intercept term for all fuel types is positive with a small numerical value for both 2001-02 and 2010-11[22], showing that all fuels are a necessity having low levels of consumption expenditures. This is also corroborated by the positive r_i^* shown in Table 9.

Table 9. Marginal Expenditure Shares and Minimum Required Expenditure for Different Fuels

2001-02	Marginal Expenditure Share (%)		Minimum Required Expenditure (Rs.)	
	Urban	Rural	Urban	Rural
Firewood	-0.001	0.016	8.00	22.85
Kerosene oil	0.000	0.004	2.56	4.31
Natural gas	0.011	0.010	20.13	2.42
Electricity	0.047	0.031	28.65	20.07
Other Fuels	0.000	0.002	2.88	10.99
Fuel	0.056	0.063	62.21	60.64
Non-Fuel	0.944	0.937	1154.30	827.82
2010-11				
Firewood	-0.002	0.009	23.95	70.59
Kerosene oil	0.000	0.000	0.96	5.72
Natural gas	0.010	0.011	48.07	4.58
Electricity	0.044	0.029	126.76	56.33
Other Fuels	0.000	0.002	5.16	31.46
Fuel	0.052	0.052	204.90	168.67
Non-Fuel	0.948	0.948	3631.44	2440.52

The analysis of marginal expenditure shares given in Table 9 shows that the marginal propensity to consume for different fuels is quite low for both urban and rural households during both the sample periods. The rural households are observed to have a relatively higher marginal consumption share of different fuels during both the years, except for electricity. The marginal expenditure share on fuels is seen to be higher in 2001-02 for both urban and rural households. Table 9 indicates that if household per capita expenditure increases by one rupee, the urban households will spend additional 5.6 percent and 5.2 percent, respectively on fuels in 2001-02 and 2010-11. In comparison, their rural counterparts will spend an additional 6.3 percent and 5.2 percent in 2001-02 and 2010-11, respectively. The earlier estimates of marginal budget shares obtained by Burney and Akhtar (1990) were lower at 2.4 percent and 2.9 percent, respectively for the urban and rural areas. The increase in marginal expenditure shares observed since the mid-1980s can be attributed to the widespread use of electrical appliances owing to the greater inflow of workers' remittances, village electrification program of the government and availability of gas in both urban and rural areas, more so in urban areas. Among the different fuel types, both the urban and rural households have a higher allocation on electricity during the two sample periods (4.7 percent *vs.* 3.1 percent and 4.4 percent *vs.* 2.9 percent, respectively).

The income elasticities for different fuels are reported in Table 10. The numerical value of all income elasticities is seen to be below unity, indicating that all fuel types are a necessity for

[22] The higher numerical values for 2010-11 reflect the effect of inflation or increase in fuel prices over the period 2002-11.

both the urban and rural households in the country. The negative sign for kerosene oil and other fuels for the urban areas in 2001-02 and for firewood, kerosene oil and other fuels for the urban areas in 2010-11 imply that these are inferior fuel for them. The income elasticities are observed to be higher for urban households in 2001-02, while they are higher for natural gas, electricity and other fuels in rural households in 2010-11, reflecting the changing patterns of fuel use for rural households due to greater availability of natural gas and electricity. The fall in income elasticity for electricity in the urban areas during 2002-11 can be attributed to growing energy shortages experienced by Pakistan in the second half of 2000, as demand exceeded available supply resulting in higher hours of load shedding by consumers. It is also worth mentioning that electricity was surplus in the early 2000s, due to which there were no supply side constraints.

The uncompensated (Marshalian) own and cross-price elasticities of the different fuel types estimated from the regression results are reported in Table 11, for both 2001-02 and 2010-11. All the estimated price elasticities have the anticipated negative sign, with the exception of kerosene oil and other fuels for urban households in 2001-02 and firewood, kerosene oil and other fuels for urban households in 2010-11. The magnitude of all estimated price elasticities is very small although non-zero, which shows that household consumption of different fuels is price inelastic.

Table 10. Income Elasticites for Different Fuels

	1984-84		2001-02		2010-11	
Fuel	Urban	Rural	Urban	Rural	Urban	Rural
Firewood	-0.088	0.301	0.154	0.088	-0.128	0.084
Kerosene oil	0.154	0.272	-0.055	0.072	-0.141	0.000
Natural gas	0.436	-	0.336	0.407	0.233	0.761
Electricity	0.351	0.712	0.629	0.223	0.383	0.375
Other Fuels	0.220	0.257	-0.171	0.047	-0.139	0.053

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11, Burney and Akhtar (1990).

Table 11. Uncompensated Price Elasticities for Different Fuels

Fuel	Urban					Rural				
2001-02	Firewood	Kerosene oil	Natural gas	Electricity	Other Fuels	Firewood	Kerosene oil	Natural gas	Electricity	Other Fuels
Firewood	-0.1484	-0.0002	-0.0017	-0.0024	-0.0002	-0.0845	-0.0004	-0.0002	-0.0019	-0.0010
Kerosene oil	0.0002	0.0526	0.0006	0.0009	0.0001	-0.0017	-0.0670	-0.0002	-0.0015	-0.0008
Natural gas	-0.0015	-0.0005	-0.3291	-0.0053	-0.0005	-0.0097	-0.0018	-0.3831	-0.0085	-0.0047
Electricity	-0.0028	-0.0009	-0.0070	-0.6163	-0.0010	-0.0053	-0.0010	-0.0006	-0.2143	-0.0026
Other Fuels	0.0008	0.0002	0.0019	0.0027	0.1656	-0.0011	-0.0002	-0.0001	-0.0010	-0.0439
Fuel	Urban					Rural				
2010-11	Firewood	Kerosene oil	Natural gas	Electricity	Other Fuels	Firewood	Kerosene oil	Natural gas	Electricity	Other Fuels
Firewood	0.1236	0.0000	0.0012	0.0032	0.0001	-0.0814	-0.0002	-0.0001	-0.0016	-0.0009
Kerosene oil	0.0007	0.1354	0.0014	0.0036	0.0001	0.0000	-0.0045	0.0000	0.0000	0.0000
Natural gas	-0.0011	0.0000	-0.2255	-0.0059	-0.0002	-0.0178	-0.0014	-0.7232	-0.0142	-0.0079
Electricity	-0.0018	-0.0001	-0.0037	-0.3769	-0.0004	-0.0088	-0.0007	-0.0006	-0.3604	-0.0039
Other Fuels	0.0007	0.0000	0.0013	0.0035	0.1305	-0.0012	-0.0001	-0.0001	-0.0010	-0.0512

Note: Figures along the diagonal are own price elasticities while figures off-diagonal are cross price elasticities.

7. CONCLUSION AND POLICY IMPLICATIONS

The purpose of this study has been to examine the inter-temporal patterns of household consumption expenditures on energy by using two sets of micro-data for the years 2001-02 and 2010-11. The paper has computed income and price elasticities for different categories of fuels using the Extended Linear Expenditure System, for the period 2001-02 and 2010-11 and has compared these with elasticities estimated by Burney and Akhtar (1990) to see whether expenditure patterns have undergone structural changes over the last 25 years in Pakistan. The study has also examined the household expenditure patterns on different fuels for both urban and rural households as well as for different expenditure quintiles. In addition, the study has also analysed the structural changes in overall energy consumption in Pakistan over the last two decades.

Analysis of micro level data suggests that electricity followed by natural gas have been the dominant fuel for urban households with access to both these fuel types rising during 2002-11. On the other hand, firewood and electricity have been the main fuels for rural households during the period with access to electricity rising for these households. It is also found that rural households spent proportionately more on fuels compared with their urban counterparts – a finding consistent with Burney and Akhtar (1990). Furthermore, per capita real expenditure on fuels was observed to rise with the rise in income across all the five expenditure quintiles with few exceptions.

Quintile wise household per capita expenditure witnessed a rise in electricity and natural gas for both urban and rural households during 2002-11, while expenditure on kerosene oil, firewood and other fuels observed decline during the period, thus indicating them as inferior fuels. The results of the study validate the Engel's Law by showing quintile-wise decline in the share of fuel in real household monthly expenditure in both urban and rural areas during the sample period. The Engel Law states that as income/ expenditure of the household increases, the share of expenditure on necessities declines. By similar account, firewood, kerosene oil and other fuels are found to be inferior fuels as the share of expenditure on these fuels declines across quintiles in both urban and rural areas over the study period. On the other hand, the expenditure share of rural households on natural gas across expenditure quintiles rises during both the sample period. In addition, the expenditure share of urban households on natural gas continued to exhibit a rising trend until the fourth quintile but drops sharply for the fifth quintile (richest households) apparently indicating a substitution away from natural gas towards electricity for cooking and heating purposes, as they could afford it.

The analysis of marginal expenditure shares suggests that the marginal budget shares for different fuels are found to be on lower side, for both urban and rural households across the sample years. However, the marginal budget shares are found to be relatively higher for rural households compared with their urban counterparts for all fuel types, except electricity. Notwithstanding low marginal budget shares for 2001-02 and 2010-11 for different fuels these are found to be higher than those obtained by Burney and Akhtar (1990) for the period 1984-85.

The income elasticities for different fuels are found to be less than unity, indicating that all fuel types are a necessity for both urban and rural households. Firewood, kerosene oil and other fuels, as expected are found to be inferior fuels for urban households in both sample periods. All

estimated own price elasticities, though small in magnitude, are found to have the expected negative signs with few exceptions (firewood, kerosene oil and other fuels). The low price elasticities indicate that these fuels are price inelastic.

The policy implications that stem out of the study suggest that as income of the household increases the demand for fuel would not rise proportionately as all fuels are found to be a necessity. Secondly, the low price elasticites of different fuels suggest that as their prices fall, their demand will not increase substantially because people will continue to buy these fuels according to their needs. Thus, the fuel import bill will not necessarily decline sharply. Furthermore, if the government reduces subsidy on different fuels, their prices will go up by definition but their demand may not decline appreciably. This is because these are necessity and the household will continue to demand according to their needs. The government may like to reduce subsidy across the consumption quintiles excepting first and second (the poorest households) to improve the country's budgetary situation without adversely affecting the relatively affluent classes.

APPENDICES

Appendix 1: Energy Consumption Data from Energy Yearbook

The analysis of macro trends in energy use presented in section II are based on data obtained from various issues of the Pakistan Energy Yearbook. The Energy Yearbook gives estimates of final commercial energy consumption in the country expressed in tones oil equivalent. The starting point for computation of this data is the commercial energy supplies of different types of primary energy sources (natural gas, petroleum products, liquefied petroleum gas, coal, electricity and nuclear) available in the country in a particular year from both indigenous and imported sources. From this primary energy supply, the transformations of different sources of energy, which includes energy utilized by gas processing plants, petroleum refineries and electric power stations are netted out. Next, the diversions of primary energy supplies, in terms of transport and distribution losses, auxiliary consumption of energy sector, and consumption for non-energy uses along with statistical difference are subtracted. The residual obtained is the final energy use in the economy, which is used in the analysis in section II of the paper. This final energy use is disaggregated into the following categories; domestic, commercial, industrial, agriculture, transport and other government. The analysis of household energy consumption presented in this section employs data available under the domestic category.

Appendix 2: Definition of Urban and Rural Areas in PIHS 2001-02 and PSLM 2010-11

The universe of both surveys – PIHS 2001-02 and PSLM 2010-11 consist of all urban and rural areas of the four provinces of Pakistan, excluding military restricted areas. Details of the urban and rural areas sampling frames developed by the Pakistan Bureau of Statistics (PBS) are given below.

Urban area

The urban area sampling frame has been developed using Quick Count Record Survey technique, under which all as cities/towns of the urban domain of the sampling frame have been divided into small compact areas known as Enumeration Blocks (E.Bs). Each enumeration block comprises about 200-250 households. Each Enumeration Block has been further divided into low, middle and high-income group, keeping in view the status of the majority of households. In PIHS 2001-02, a total of 22,800 enumeration blocks in all urban areas of the country were used for sampling. In PSLM 2010-11, the urban areas sampling frame consisted of 26,698 enumeration blocks which had been updated through Economic Census conducted in 2003.

Rural areas

With regard to the rural areas, the lists of villages/mouzas/dehs according to Population Census, 1998 have been used as sampling frame. In this frame, each village/mouza/deh is identifiable by its name, Hadbast number and cadastral map, etc. The rural frame of both PIHS 2001-02 and PSLM 2010-11 comprised of 50,588 mouzas/villages/dehs.

Appendix 3: Energy Expenditure Data from Household Surveys (PIHS and PSLM)

The data pertaining to household expenditures on energy analysed in Section V and VI of the paper has been obtained from the PIHS 2001-02 and PSLM 2010-11 datasets. This data has been extracted from the fuel and lighting category of monthly household expenditures reported in the HIES modules of both the surveys (under item code 2700). The items covered under the fuel and lighting category along with their definition is consistent across both these surveys so their results are directly comparable[23]. The fuel types covered under the fuel and lighting category in both PIHS and PSLM are presented in the table below:

Fuel type	Item Code
Fire wood	2701
Kerosene oil	2702
Char coal	2703
Coal hard & soft peat	2704
Dung cake (dry)	2705
Gas (pipe), Gas (cylinder)	2706
Electricity	2707
Match box, Candles, Mantle, etc.	2708
Bagasse, Agricultural wastes for fuel purposes (cotton sticks, sawdust, shrubs, weeds, tobacco sticks, etc.),	2709

Piped gas and cylinder gas appear as separate items in PIHS 2001-02.

For the purpose of analysis in the paper, the above 9 categories have been regrouped into

[23] It needs to be clarified that the fuel and lighting category of household energy expenses excludes expenditures on petrol/ diesel incurred for running of motor car/ motorcycle. These expenditures are captured under the 'personal transport and travelling' category in both the surveys under item code 4301.

the following 5 main categories, while one item - match box, candles, mantle, etc., has been dropped from analysis due to having no direct link with household energy use:

Fuel type	Items Included
Fire wood	Fire wood
Kerosene oil	Kerosene oil
Natural gas	Gas (pipe), Gas (cylinder)
Electricity	Electricity
Other fuels	Coal hard & soft peat, Dung cake (dry), Bagasse, Agricultural wastes for fuel purposes

Appendix Table 1: Households' Expenditure on Different Fuels

Year	Average household expenditure (Rs. per month)		Average household expenditure per capita (Rs. per month)	
2001-02	Urban	Rural	Urban	Rural
Firewood	63.52	160.98	9.38	24.90
Kerosene oil	13.70	26.65	2.43	4.62
Natural gas	171.89	23.87	29.84	3.92
Electricity	412.49	160.74	72.78	25.40
Other Fuels	16.39	70.59	2.47	11.48
Total Fuel	677.99	442.82	116.91	70.32
Total Non-Fuel	8,663.41	5,580.50	1,476.25	847.11
2010-11				
Firewood	133.37	466.85	21.33	76.68
Kerosene oil	5.29	33.99	0.85	5.74
Natural gas	347.21	95.07	61.88	16.46
Electricity	1,110.02	514.28	200.32	87.12
Other Fuels	27.31	194.45	4.56	33.13
Total Fuel	1,623.20	1,304.64	288.94	219.14
Total Non-Fuel	23,005.51	16,269.83	4,043.73	2,621.40

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

Appendix Table 2: Average Per Capita Household Expenditure and Income by Expenditure Quintile (Rs.)

Expenditure quintiles	Average per capita total household monthly expenditure		Average per capita household monthly income		Average per capita monthly expenditure on fuel	
2001-02	Urban	Rural	Urban	Rural	Urban	Rural
First	894.30	746.32	1,013.57	828.63	91.86	67.66
Second	958.90	780.07	1,032.14	795.06	90.15	62.23
Third	1,067.83	875.67	1,175.71	897.99	89.83	65.58
Fourth	1,239.99	1,024.43	1,340.72	1,046.39	98.54	75.32
Fifth	2,649.61	1,449.76	3,090.78	1,508.00	165.18	92.20
2010-11						
First	2,463.31	2,262.63	2,508.64	2,254.54	215.40	203.99
Second	2,724.86	2,390.52	2,744.37	2,473.63	209.02	199.43
Third	3,061.80	2,684.83	3,435.53	2,750.50	216.82	209.78
Fourth	3,718.32	3,065.72	4,031.48	3,220.74	253.53	220.22
Fifth	7,360.28	4,554.04	9,118.13	5,432.19	441.07	290.80

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

Appendix Table 3: Average Per Capita Household Expenditure by Type of Fuel and expenditure Quintile (Rs.)

Expenditure quintiles	Firewood		Kerosene oil		Natural gas		Electricity		Other fuels	
2001-02	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
First	16.60	23.05	4.29	4.63	19.37	1.47	44.51	22.15	7.08	16.36
Second	13.21	23.09	3.70	4.31	19.74	2.60	50.10	20.75	3.40	11.48
Third	11.14	25.23	2.75	4.29	24.14	3.70	49.13	23.23	2.66	9.15
Fourth	7.93	27.90	2.18	4.73	28.38	5.97	58.35	28.10	1.70	8.61
Fifth	5.42	27.29	1.25	5.62	41.95	8.90	115.55	40.81	1.01	9.58
2010-11										
First	45.31	75.85	1.78	7.16	41.33	6.32	115.12	72.36	11.86	42.29
Second	29.70	76.25	0.94	5.84	44.60	10.64	127.25	73.76	6.54	32.93
Third	23.13	75.49	0.94	5.73	49.75	15.18	138.81	84.27	4.19	29.11
Fourth	15.12	78.75	0.68	4.97	60.54	19.38	173.94	89.35	3.26	27.77
Fifth	10.25	77.98	0.47	4.01	89.44	42.38	339.25	136.75	1.65	29.67

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

Appendix Table 4: Pattern of Household Expenditure on Fuel by Expenditure Quintile

Expenditure quintiles	Average household monthly expenditure (Rs.)		Average household monthly income (Rs.)		Share of fuel in household monthly expenditure (%)	
2001-02	Urban	Rural	Urban	Rural	Urban	Rural
First	2,949.22	2,906.34	3,259.55	3,136.27	10.39	9.09
Second	4,455.27	4,412.42	4,623.06	4,436.89	9.50	7.97
Third	5,830.82	5,785.74	6,225.01	5,934.80	8.73	7.42
Fourth	7,814.36	7,742.77	8,454.58	7,887.57	8.05	7.22
Fifth	16,643.90	13,458.73	19,080.88	14,030.61	6.25	6.26
2010-11						
First	8,818.86	8,513.75	8,890.61	8,305.12	8.74	8.89
Second	12,807.26	12,693.88	12,594.52	12,749.95	7.67	8.20
Third	16,714.07	16,662.03	18,478.36	16,913.06	7.14	7.69
Fourth	22,277.60	22,085.67	23,612.87	22,807.25	6.71	7.13
Fifth	45,092.91	37,424.76	54,859.37	43,773.80	6.06	6.44

Source: Authors' calculations using PIHS 2001-02 and PSLM 2010-11.

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