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RESEARCH PAPER

Factors Influencing the Choice between Dirty and Clean Energy Sources: Evidence from Pakistan

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ABSTRACT

Energy Ladder Hypothesis (ELH) explains the relationship between income and households' decision to use dirty or clean energy sources for the purpose of cooking, heating, and lightening. Therefore, the underlying research paper aims to estimate the validation of the ELH in Pakistan, moreover, to estimate the other socioeconomic factors which influence the households' decision to use energy sources. We have used HIES (2018-19). The findings identify that ELH holds in Pakistan, which explains that the increase in income level drives households to shift from dirty energy (firewood, dung cake, charcoal, agriculture waste) utilization to the clean energy sources (electricity, and gas). Moreover, higher quintiles of income are found using cleaner energy sources than the bottom income quintiles. ELH holds by using income quintiles. Other factors such as household characteristics (family size, dependency ratio, education, gender, and locational dwelling) are found influencing the decision to use dirty or clean energy sources.

Introduction

Primarily, the underlying study aims to estimate the validation of the Energy Ladder Hypothesis (ELH) and other socioeconomic determinants of the households' decision to use dirty or clean energy sources for the purpose of cooking, heating, and lightening in Pakistan. The ELH explains the relationship between income and types of energy used by households. This hypothesis ranks different energy sources in accordance with quality, ease of use, and price of the source, and further elaborates these ranks as bottom ranked energy sources or solid fuels (wood and coal), middle ranked sources or liquid fuels (natural gas and kerosene oil), and finally top ranked sources such as electricity and solar (Leach, 1992). These consumable energy sources have also been categorized into dirty (crop wastage, firewood, coal or charcoal, animal dung, and kerosene oil) and clean (gas, electricity) energy sources, depending upon their after-consumption emissions and hazardous impacts on environment and human health (Hanna & Oliva, 2015).

The developed countries have explored certain new forms of energy sources, which are considered as environment-friendly sources such as energy generated through wind, solar-heat, and hydroelectricity, which have become the source to alleviate the CO2-emissions, and their low prices enhance the demand of energy usage (Tampakis et al., 2017). However, in case of developing nations like the Pakistan, where a large chunk of population relies on traditional biomass, crop-residual, and wood for energy purpose, the efforts of introducing renewable energy sources remained slow. Pakistan largely imports the energy resources to fulfill the country's demand which raises the cost of energy usage,

leaving no choice for poor households to either live without electricity or use the traditional sources (Zaigham & Nayyar, 2005).

The usage of households' energy demand varies by rural and urban areas, income, and composition of socioeconomic characteristics of households. According to Pakistan Bureau of Statistics (PBS), the estimates of households' demand for fuel energy during 2015-16 indicates that fire wood used by 20.7%, Kerosene oil (0.61%), charcoal (0.44%), dung cakes (5%), generator (2.9%), cotton sticks (3.44%), wastage (3.43%), while gas (13%) and 53% households are found using the electricity as a source of fuel energy for cocking and lightening in Pakistan. Nonetheless, a little decline in the demand of fire wood (18.3%), Kerosene oil (0.17%), charcoal (0.31%), dung cakes (3.23%), generator (0.9%), and cotton sticks (3.43%), wastage (3.35%) is observed during 2018-19, while 2% and 1% increase in the demand of electricity and gas usage respectively has been observed in 2018-19 as compared to the years of 2015-16 in Pakistan.

Furthermore, the rural and urban differences in terms of household energy demand for cocking and lightening indicate that in rural areas, around 31% households use fire wood, dunk cakes (7.78%), cotton sticks (5.40%), while and 5.42% households use other agriculture wastage for cocking and lightening purpose during 2015-16. However, in urban areas, these sources are significantly low in usage by households, while in urban areas gas and electricity is the one of highly used source of energy for domestic use during the 2015-16.

Likewise, during 2018-19, the overall trend of household energy demand estimates remains same it is observed during 2015-16. But, around 2% decline is observed for rural and urban differences in the period of 2018-19 as compared to the 2-15-16. These estimates evidently suggested that households living in rural areas are using relatively dirty and environmentally not feasible sources of energy for cocking and lightening in Pakistan.

The literature indicates different socioeconomic factors which influence the choices to use energy sources such as poverty, income differences, household size, education, and locational variables play significant role to determine the households' decision to use energy for the purpose of cooking, heating, and lightening (Ashagidigbi et al., 2020; Ali et al., 2019). The underlying study has bridged up the gap by classifying the energy sources into dirty and clean with respect to their ranking as given energy ladder hypothesis (Leach, 1992).

Literature Review

The energy utilization is linked with capability and freedom of the households. The denial to such freedom takes into the energy poverty, where a household fails to value its preferences owing to financial constraints (Sen, 2000). So, the lack of access to the affordable energy sources result in multiple form of the injustice. For instance, the usage of electricity, and natural gas would keep the family members safe from being ill, and it could save the time and enable the children to spend more time on study (Samarakoon, 2019).

Some studies reveal that the access to the clean energy calls for policy intervention. For that the economic affordability of the households expands the capacity of the individuals to have accessibility to the clean energy resources. The financial limitations of the households squeeze the capacity to substitute the quality energy sources. Nonetheless, the expansion of the financial freedom leads to the positive income or wealth effect, which influences the substitution of the energy resources (i.e. Acharya and Sadath, 2019; Ozughalu and Ugwumike, 2019). Further evidence demonstrates that the rich countries spend more on quality energy sources which have less CO2 emissions. Likewise, the

wealthy individuals have higher pattern of spending on quality and environment-friendly energy appliances than the poor households (Leach, 1992).

Similarly, socioeconomic characteristics of the households have also significant implications on determining its decision to spend money what source of the energy. Such as the Moeen et al. (2016) have suggested what factors influence the households' choice to consume on energy sources in Pakistan. Such factors include household income, family size, dependency ratio, education, employment status, and community-based variables. Likewise, Rahut et al., (2019) have indicated the factors household's socioeconomic characteristic specifically households' asset ownership, and poverty status are the prominent determinant of the households' choice regarding energy usage for cocking and lightening. Moreover, in addition to income and asset holding, the gender of household head is found one of the important factors in existing literature. In rural areas, females play significant role in collecting the wood, cotton sticks, and dung cakes etc. (Gupta et al., 2020).

Theoretical Framework

Leach (1992) has explained the relationship between income and types of energy used by households, which is known as Energy Ladder Hypothesis (ELH). This hypothesis demonstrates that increase in household income brings about the expansion in households' adaptive capacity and makes them able to shift from dirty energy sources to the quality energy sources. Furthermore, the hypothesis ranks different energy sources in accordance with quality, ease of use, and price of the source, and further elaborates these ranks as bottom ranked energy sources or solid fuels (wood and coal), middle ranked sources or liquid fuels (natural gas and kerosene oil), and finally top ranked sources (electricity and solar).

The above-mentioned consumable energy sources have also been categories in terms of dirty and clean energy sources, which are mainly depending upon their after-consumption emissions and hazardous impacts on environment and human health. As dirty energy sources comprise of crop wastage, firewood, coal or charcoal, animal dung, and kerosene oil, whereas clean energy sources include natural gas (both piped and LPG), electricity and solar energy. Hanna & Oliva, (2015) have employs the foundations of the energy ladder hypothesis to investigate the relationship between energy choices and cash transfer program. Cash transfers provide additional income to the poor households and increases the adaptive capacity of the households to shift from dirty sources to the clean energy sources.

The other aspect of the energy ladder hypothesis can be viewed by Amartya Sen (1999) and Nussbaum (2011), who have conceptualized the "Capabilities Approach" in economic development and they claimed that economic development must be seen as a freedom of choices based on the capabilities to attain what they value as a decent life. In an energy poverty framework, the capabilities approach states that the deficiency of access to modern energy services should not be viewed only reaching certain level of per capita use of energy. Not only the lack of access to modern energy services imply a lack of basic energy needs (i.e. cooking, heating and lighting) but also it is a restrictive to development because it affects the good health, education and the ability to participate economically and politically (Gonzalez-Eguino, 2015) This approach proposed by Amartya Sen provides the basics to energy ladder hypothesis, which is particularly useful for understanding what constitute energy poverty and how to tackle the energy poverty problem (Sadath and Acharya, 2017).

Data Source and Methodological Framework

Data and Variable Description

Primarily, the study has used nationally representative household survey dataset, known as HIES for the year of 2018-19, which is conducted by the Pakistan Bureau of Statistics (PBS). We have employed total sample of the survey is 24,809 households.

We have measured energy demand in two ways: (1) household expenditure shares on energy is used to measure whether households are spending on dirty sources (firewood, charcoal, dung cake, and agriculture waste) or on clean energy sources (electricity and gas), and (2) households expenditures on each items is used to determine energy demand. The rests of the variables such as households' socio-economic characteristics are described in table-1.

Table 1
A Brief Description of the Variables

Variables Name	Brief Description of the Variables	Units
Household Energy		
Dirty versus Clean	Binary variable takes 1 for dirty (firewood, dung cake, agriculture waste, charcoal), 0 for clean sources (electricity, gas)	Binary
Dirty Expenditure Share	Share of dirty energy to the total monthly energy expenditures	%
Household Income		
Monthly Income	Total monthly income earned by working members in a family	PKR
Income Quintiles	Five income quintiles from the poorest to richest is constructed	Binary
Household-Specific Factors		
Head Age	Age of the head to the date survey is conducted	Years
Gender of Head	Binary variable takes 1 for male-headed, while 0 for female	Binary
Education of Head	Binary variables for no education, primary, secondary, and above matriculation.	Binary
Family Size	Counting the total family members in household	Integer
Dependency Ratio	sum of non-working age group (below 15 years + members above 64 years) divided by the working age group (between 15 to 64 years)	Ratio
Improved Water	Binary variable take 1 if household has improved sources of water, while 0 for not having	Binary
Locational	1=rural areas, and 0 for urban	Binary

Methodological Framework

The specification of the econometric models is laid down as follows.

$$Y_i = \alpha_0 + \delta Z_i + \beta X_i + \varepsilon_i \quad (1)$$

In above equation, Y_i demonstrates the dependent variable which represents for household energy choices for cooking, heating, and lightening purposes. Similarly, Z_i denotes for monthly household income, while X_i the socioeconomic factors of the households such as age, gender, and education of household head, dependency ratio, and locational variables such as rural/urban variables, and, ε_i demonstrates for the error term of the model.

The equation (1) is the general specification of the model. As we have discussed in previous sections, that dependent variable is estimated two ways: share of dirty expenditures to the total expenditures, and expenditures by each item of energy sources.

a) The model has been estimated through OLS, when dependent variable is share of dirty expenditures to the total energy expenditures.

b) The on-going study has employed the same econometric strategies when we have used five quintiles of the income to estimate how households move to energy sources as he/she improves income class

The energy ladder is estimated as by using the log of household monthly income. If it has negative sign but statistically significant when dependent variable is set for dirty choices (i.e.$\delta < 0$), which identifies that increase in income leads to the decrease of dirty sources and household moves to the quality sources of energy.

Results and Discussion

Estimation of the Energy Ladder Hypothesis in Pakistan

Energy ladder hypothesis assumes that the higher level household income encourages households to spend more share of income on quality energy items rather than dirty source of energy items. Table-2 comprises estimated results which have tested the validation of energy ladder hypothesis. The estimated results indicate that log of household income have negative and statistically significant influences on share of the dirty expenditure. The negative sign demonstrates that other things remaining same, on average with the increase of household income, households reduce share of dirty expenditures to the total energy consumption by 5 percent. The reduction in dirty energy consumption means households are shifting from dirty to quality energy sources for cooking and lightening purposes. Evidently, it demonstrates the validation of the energy ladder hypothesis. These findings highlight that positive income effect has positive substitution effect that households tend to substitute dirty sources with quality sources due to increase in household monthly income. The dirty sources include kerosene, firewood, dunk cake, charcoal, and agriculture waste, while quality energy sources which are environmentally friendly include electricity and gas.

In order to estimate the differences between different incomes quintiles, five quintiles are classified which observe from the poorest to the richest households. The underlying study has introduced income quintiles by dropping the household income from model. For that purpose, first quintile which represents the poorest households is set as reference category. This could help to understand the validity of energy ladder hypothesis from alternative aspects. The estimated results are demonstrating that the negative sign with the estimates of all income quintiles relative to the first quintile. The negative sign highlights that the as the households move to the higher level of income group, they are spending less on dirty sources relative to the quality source of energy usage. Moreover, the coefficients of all these quintiles are also increasing (table-2).

The estimates come out as first quintile (3%), second quintile (6%), third quintile (9%), and the richest quintile has decline in expenditures on dirty energy sources by 11 percent respectively. The rising coefficients along with negative signs determine that as the level of income increases or households move into higher group of income, they tended to shift from dirty energy source to the quality energy sources, other things remaining same. In short, this analysis also validates that the energy ladder hypothesis holds in Pakistan. Furthermore, it also shows that these results are robust even if we categorize the income groups (table-2).

The locational variable which is measured in binary form (1= rural, 0=urban) has positive and significant influences on dirty energy expenditures. The positive sign means that other things remaining same, those households which are residing in rural areas as compared to those who live in urban areas are increasing their expenditures on dirty energy sources by 17 percent such as kerosene, charcoal, dung cake, fire wood, and agriculture wastage. These findings establish two things: 1) increase in usage of the dirty fuel choices is pertaining to the rural phenomena, while it is relatively less in urban areas, and 2) households who live in rural areas perhaps have lacking of the access of gas availability while the underutilization of the electricity as fuel source is not much experienced due to relatively economically costlier. Moreover, the provincial dummies have also statistically significant influences on the share of dirty energy sources in total expenditures on energy sources (table-2).

Table 2
Energy Ladder Estimation from the Application of OLS

	(1)	(2)
VARIABLES	With Income Quantiles	With Log Income
Log income		-0.0518***
		(0.00242)
Second IQ	-0.0307***	
	(0.00521)	
Third IQ	-0.0684***	
	(0.00511)	
Fourth IQ	-0.0939***	
	(0.00518)	
Fifth IQ	-0.118***	
	(0.00537)	
HH size	0.00352***	0.00244***
	(0.000506)	(0.000499)
Head age	-0.000569***	-0.000611***
	(0.000110)	(0.000109)
Dependency ratio	0.00263	0.00557***
	(0.00191)	(0.00189)
Head gender	0.0630***	0.0441***
	(0.00512)	(0.00465)
Head married	0.0176*	0.0124
	(0.00944)	(0.00930)
primary	-0.0221***	-0.0226***
	(0.00415)	(0.00416)
secondary	-0.0488***	-0.0531***
	(0.00353)	(0.00352)
Above metric	-0.0612***	-0.0624***
	(0.00429)	(0.00431)
Improved water	-0.0543***	-0.0543***
	(0.00332)	(0.00333)
Flush toilet	-0.139***	-0.141***
	(0.00459)	(0.00459)
Rural	0.173***	0.174***
	(0.00313)	(0.00313)
Sindh	-0.0629***	-0.0655***
KP	-0.0174***	-0.0201***
Blochistan	-0.0124*	-0.0164**

Constant	0.328***	0.820***
Observations	24,677	24,679
R-squared	0.376	0.374

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The results related to regional dummy indicates that households living in rural areas are not using electricity more as compared to urban areas. People living in rural areas spend more on gas, while they are tending to increase the dirty source of energy. Hence, the energy ladder hypothesis may sustain at urban areas while may not sustain in rural areas (table-2).

Validation of Energy Ladder Hypothesis by Energy Groups

The estimated results indicate that on the whole energy ladder hypothesis holds even we have disaggregated the energy expenditures with respect to energy sources. It is evident that with the increase of income, households tend to increase the expenditures on electricity by almost 5 percent, other things remaining same. Electricity is one of the quality energy sources. The positive sign identifies that with the higher level of income, households are tending to move on quality energy sources. Likewise, the case of expenditures on gas, the validity of energy ladder hypothesis holds. Where, positive sign of the coefficient demonstrates that households are more tending to spend more on quality of energy sources (table 3).

Table 3
Energy Ladder Hypothesis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Electricity	Gas	Kerosene	Firewood	Charcoal	Dung cake	Agri waste
Log income	0.0495***	0.00831**	-0.0174	-0.0291***	0.0130	-0.0156**	-0.0289***
	(0.00367)	(0.00420)	(0.0175)	(0.00348)	(0.0432)	(0.00923)	(0.00686)
HH size	-0.00671***	-0.00651***	-0.00127	-0.00204***	-0.00602	-0.00230	-0.00145
	(0.000755)	(0.000863)	(0.00265)	(0.000681)	(0.00731)	(0.00178)	(0.00146)
Head age	0.000853***	-0.00091***	-0.000517	-0.000235	0.000507	-0.00128***	-0.000713**
	(0.000166)	(0.000192)	(0.000617)	(0.000155)	(0.00203)	(0.000410)	(0.000331)
Depend. ratio	-0.008***	-2.01e-05	-0.00210	-0.00396	0.00122	0.0142**	0.00581
	(0.00279)	(0.00350)	(0.0123)	(0.00273)	(0.0315)	(0.00671)	(0.00546)
Head gender	-0.0281***	-0.0199**	0.0325	0.0173**	-0.0349	-0.00929	0.0164
	(0.00733)	(0.00868)	(0.0425)	(0.00791)	(0.0866)	(0.0205)	(0.0152)
Head married	-4.80e-05	0.00256	0.0221	0.0277*	-0.0384	0.0568	0.00578
	(0.0144)	(0.0167)	(0.0599)	(0.0162)	(0.179)	(0.0409)	(0.0360)
Primary	0.00236	0.0173**	-0.0554*	-0.00132	0.0896	-0.0458***	-0.0110
	(0.00606)	(0.00734)	(0.0303)	(0.00579)	(0.0757)	(0.0144)	(0.0112)
Secondary	0.0434***	0.00751	-0.00847	-0.000283	0.114**	-0.0735***	-0.0225**
	(0.00546)	(0.00619)	(0.0269)	(0.00544)	(0.0578)	(0.0141)	(0.0107)
Above metric	0.0772***	-0.0145*	-0.0182	-0.000166	0.103	-0.110***	-0.0237
	(0.00699)	(0.00739)	(0.0260)	(0.00785)	(0.0917)	(0.0231)	(0.0161)
Improved water	0.0401***	0.0184***	0.00859	-0.00537	0.167***	-0.00781	-0.0710***
	(0.00477)	(0.00611)	(0.0241)	(0.00427)	(0.0500)	(0.0112)	(0.00832)
Flush toilet	0.0822***	0.0332***	0.0515	-0.00485	-0.0258	-0.00103	-0.0754***
	(0.00576)	(0.0122)	(0.0348)	(0.00489)	(0.0636)	(0.0129)	(0.0105)
Rural	-0.325***	0.0193***	0.0460	0.0183***	0.126**	0.0388*	-0.0280
Sindh	0.160***	-0.0101	-0.0800*	-0.0795***	0.0344	0.337***	0.0997***
KP	0.182***	-0.0382***	-0.0366	-0.0454***	0.129	0.288***	-0.0255*
Blochistan	-0.00150	0.281***	-0.157***	0.00122	0.167**	0.348***	-0.0896***
Constant	-0.146***	0.281***	0.339*	1.216***	0.365	0.440***	0.580***

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The other aspect of the validity of holding energy ladder can be confirmed by looking into the expenditures on dirty sources. The estimated results indicate that other

things remaining same, the increase in income would bring about decrease in households expenditures on kerosene by 1.7 percent, although findings are statistically insignificant. Moreover, the results obtained for firewood are found statistically significant with negative sign. Other things remaining same, with the increase of income, households are tending to bring about decrease the expenditures on firewood by almost 3 percent, while there is no significant impact on the charcoal. Likewise, negative and significant influences are found for dung cake and agriculture waste as well. Similarly, the classification of income groups into five income quintiles demonstrate that the higher income quintiles are consuming quality energy sources as compared to the dirty energy sources, which also establishes the validation of the ladder hypothesis (table 3A).

Table 3A
Income Quanitiles and Energy Expenditures: Energy Ladder Hypothesis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Electricity	Gas	Kerosene	Firewood	Charcoal	Dung cake	Agri. waste
Second IQ	0.00910	-0.00611	-0.0214	-0.0240***	-0.0687	0.0106	-0.0206*
	(0.00712)	(0.0101)	(0.0356)	(0.00564)	(0.0833)	(0.0162)	(0.0122)
Third IQ	0.0247***	-0.00771	-0.00283	-0.0469***	-0.0323	0.0122	-0.0453***
	(0.00727)	(0.00952)	(0.0373)	(0.00649)	(0.0824)	(0.0172)	(0.0134)
Fourth IQ	0.0555***	-0.0110	0.0166	-0.0568***	-0.0616	-0.00715	-0.0641***
	(0.00763)	(0.00940)	(0.0394)	(0.00721)	(0.0894)	(0.0189)	(0.0145)
Fifth IQ	0.0995***	-0.00751	-0.0272	-0.0699***	0.00865	-0.0388*	-0.0832***
	(0.00841)	(0.00996)	(0.0364)	(0.00892)	(0.0888)	(0.0226)	(0.0168)
HH size	-0.00729***	-0.00598***	-0.00165	-0.00126*	-0.00687	-0.00199	0.000114
	(0.000776)	(0.000875)	(0.00258)	(0.000702)	(0.00777)	(0.00183)	(0.00150)
Head age	0.000789***	-0.000890***	-0.000508	-0.000165	0.000595	-0.0012***	-0.000641*
	(0.000167)	(0.000194)	(0.000619)	(0.000157)	(0.00207)	(0.000413)	(0.000331)
Depend ratio	-0.00606**	-0.00113	-0.000646	-0.00558**	-0.00468	0.0135**	0.00269
	(0.00282)	(0.00355)	(0.0124)	(0.00277)	(0.0319)	(0.00677)	(0.00548)
Head gender	-0.0328***	-0.0150	0.0304	0.0311***	-0.0114	-0.0153	0.0231
	(0.00780)	(0.00922)	(0.0440)	(0.00808)	(0.0923)	(0.0215)	(0.0160)
Head married	-0.00225	0.00382	0.0269	0.0293*	-0.0339	0.0545	0.00726
	(0.0145)	(0.0167)	(0.0622)	(0.0162)	(0.176)	(0.0410)	(0.0358)
primary	0.00267	0.0178**	-0.0577*	-0.00102	0.0926	-0.0454***	-0.00840
	(0.00605)	(0.00733)	(0.0302)	(0.00578)	(0.0747)	(0.0145)	(0.0112)
secondary	0.0413***	0.00911	-0.0114	0.00227	0.124**	-0.0731***	-0.0180*
	(0.00548)	(0.00621)	(0.0271)	(0.00548)	(0.0604)	(0.0142)	(0.0108)
Above metric	0.0744***	-0.0109	-0.0219	0.00324	0.110	-0.106***	-0.0160
	(0.00704)	(0.00733)	(0.0256)	(0.00810)	(0.0900)	(0.0233)	(0.0163)
Improved water	0.0405***	0.0191***	0.00626	-0.00556	0.169***	-0.00779	-0.0704***
	(0.00477)	(0.00611)	(0.0244)	(0.00427)	(0.0499)	(0.0112)	(0.00831)
Flush toilet	0.0830***	0.0341***	0.0432	-0.00360	-0.0318	-0.00192	-0.0737***
	(0.00576)	(0.0122)	(0.0339)	(0.00491)	(0.0644)	(0.0129)	(0.0105)
Rural	-0.325***	0.0182***	0.0476	-0.0193***	0.136**	0.0371*	-0.0292*
Sindh	0.158***	-0.00861	-0.0797*	-0.0775***	0.0203	0.338***	0.101***
KP	0.181***	-0.0371***	-0.0347	-0.0459***	0.123	0.285***	-0.0257*
Balochistan	-0.00139	0.283***	-0.160***	0.00270	0.174**	0.346***	-0.0874***
Constant	0.325***	0.320***	0.179*	0.940***	0.503**	0.292***	0.309***

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

By concluding the above discussion, we have estimated the validation of the energy ladder hypothesis by disaggregating the energy expenditures by each energy source used by households. We can find two major reasons which determine the validation of the energy ladder hypothesis. First, positive income effect becomes the primary reason. The increase in income level of the households brings about increase in their ability to purchase more, which ultimately influences the households' ability to purchase quality energy sources such as electricity and gas. Second, in addition to positive income effect, substitution effect dominates which encourages households to reduce the expenditures on dirty energy sources such as kerosene, dung cake, firewood, agriculture wastage, and charcoal.

Other Factors Influencing Household Energy Choices

Other than household income, there are some other household-specific and locational factors which influence the decision to use the energy sources for cooking and fueling purposes. Estimated results demonstrate that gender of household head has statistically significant influences on households' expenditures on dirty energy sources. The estimates encompasses positive sign which means that if household head has male gender relative to the female-headed, then the household would raise his more expenditures on dirty energy sources such as kerosene, charcoal, firewood, dunk cake, and agriculture wastage than quality energy sources. Moreover, age of the household head has also statistically significant impacts on dirty energy usage. The negative sign indicates that households who are relatively older are reducing their expenditures on dirty energy sources. Similarly, marital status also has significant impacts with negative on dirty energy expenditures. It indicates that married household heads are reducing their expenditures on the usage of dirty sources (table-2).

Education of household head has also statistically significant influences on household dirty energy expenditures. We have introduced four categories such as no education set as reference group, while primary, secondary, and above matriculation are the educational dummies. The estimated results demonstrate that educated households are spending less on dirty energy sources. The higher the level of education of household head, the lesser households' expenditures on dirty sources will be. Moreover, the higher level of education, the larger coefficient of the estimates is observed such as primary (2%), secondary (4%), and above metric education (6%). Hence, we can conclude that education variable has appeared to be the significant factor which determines households' decision to spend money whether on dirty sources or quality energy sources (table-2).

Likewise household head specific factors, there are some household related factors which have significant influence on aforesaid outcomes. For instance, household size which is measured by the count of the total family members has significant impacts on households' expenditures on dirty energy sources. The positive sign suggests that other factors remaining same, those families which have larger family size are found increasing the expenditures on dirty energy sources. Similarly, dependency ratio has significant impacts with positive signs, which demonstrate that other things remaining same, those families which have higher age dependency ratio are found increasing the expenditures on dirty expenditures. Age dependency ratio is measured through the ratio of non-working age group to the working age group, which measures the how much a family contains dependency ratio. The findings estimated for this variable reflect that concerned households have more financial pressure on working family members, which ultimately influenced the consumption pattern of the households (table-2).

Household living standard related indicators such as access to improved water and access to the toilet facility which determines the households' housing quality and hygiene. The estimated results are suggestive that these two factors have statistically significant impacts on households' expenditures for dirty energy sources. The negative signs

determine that those households who have quality housing are reducing their expenditures on dirty energy sources, other things remaining same.

Conclusion

The energy ladder hypothesis explains that limited financial capacity leads households to choose dirty source of energy (firewood, charcoal, dung cake, and agriculture waste) relative to the quality sources (electricity and gas). If a household becomes able to expand its financial capacity, he/she would move to the quality source of the energy utilization. Primarily, the ongoing research aims to estimate the validation of the energy ladder hypothesis in the case of Pakistan, and moreover to determine what are the other factors which determine the choice of energy source (dirty versus clean). We have applied different econometric techniques depending on the nature of the dependent variables. The findings identify that energy ladder hypothesis holds in Pakistan, which explains that the increase in income level drives households to shift from dirty energy (firewood, dung cake, charcoal, agriculture waste etc.) utilization to the clean energy sources (electricity, and gas). Further findings disclose that other factors such as household characteristics (family size, dependency ratio, education, gender, and locational dwelling) are found influencing the decision to use dirty or clean energy sources.

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