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Impact of Rising Energy Prices on Consumer's Welfare: A Case Study of Pakistan

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This work investigated the impact of higher energy prices on consumer's welfare for the Pakistan from 1987 to 2012. The central objective of the study is to quantify the consumer welfare through Compensating Variation (CV) after estimating the demand elasticities by applying the Linear Almost Ideal Demand System (LA/AIDS) for main energy sources. Welfare change is also measured in four scenarios (two price shocks) for Pakistan in order to analyse the impact of energy price change in different time period. Coal, gasoline and High Speed Diesel (HSD) oil are relatively less elastic, where High Octane Blended Component (HOBC), kerosene and Compressed Natural Gas (CNG) are relatively more elastic, while electricity and natural gas is unit elastic. Additionally, the results of Compensating Variation suggest that due to higher energy prices, more income compensation is required to pay for consumer in order to achieve the initial energy utility. So mixture of price controlling and income policies should be adopted for each energy source.

JEL Classification: D6, Q4
Keywords: Rising Energy Prices, Consumer Welfare, LA/AIDS, CV, Time Series Data

INTRODUCTION

In developing countries like Pakistan, energy is to be considered the one of the most significant sector because almost all the economic activities depend on energy. Energy development is directly related to well-being along with success throughout the world. Advance energy improves the lives of people [Ramchandra and Boucar (2011)]. The main two components of global energy situation are rapid population increase and the increase in the living standard associated with entire societies. Per person energy consumption is considered as degree of per person income as well as welfare of any nation [Rai (2004)].

Energy supply is also a source of providing the fuel to fruitful activities which include farming, trade, manufacturing, industries as well as exploration. Then again, a reduction in supply of energy plays a part in poverty and starvation that may contribute to fall in economic growth as well as prosperity [Azarbaijani, *et al*. (2012)]. Within the period association with globalisation, higher energy demand as well as dependency on

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energy for any nation suggests that energy will be considered as the most significant issues at world level in next century. Almost all the economic sectors are interconnected with each other due to energy circulation in all of these areas, so almost any changes in energy price ranges effect the whole economy and left the significant results [Azarbaijani, *et al*. (2012)]. Especially this is why energy pricing is to be considered more difficult than ordinary goods pricing. In the developing nations like Pakistan, this matter is to be taken as leading concern. Having rising industrial sectors in addition to higher population growth rate, the demand for energy throughout Pakistan is set to increase in future [Haider, *et al*. (2013)]. Suitable pricing is, yet, to be taken as necessary situation for encouraging energy efficiency and for attaining any sustainable energy segment [Erbaykal (2008)].

Global oil price is taken to be as a main cause of energy inflation because few nations are responsible to control the supply of oil and any disturbance in its supply leads to sudden rise in the prices. Pakistan is the net importer of oil and any disturbance in oil supply makes Pakistan helpless by putting subsequent burden on its import bills [Haider, *et al*. (2013)]. International economic depression in 1970 due to oil shocks produced by OPEC created a serious problem for oil importing nations around the world and led to sudden rise in energy prices and created a large demand gap. Oil importing nations were unable to maintain the huge energy demand and energy policy goals to fill this specific gap to ensure that such kind of recessions usually do not take place once again [Kolev and Riess (2007)]. Since 2000, global oil prices have been increased but this increase has been seen very sharp from 2003 to 2008 then international oil prices have been increased from 2010 to 2013 [Tlhalefang and Galebotswe (2013)]. Higher oil selling prices reduce true wealth and consumption spending [Malik (2008)]. A rise in oil price expects to experience a reduction in total welfare by 20 percent for oil importing countries [Thoresen(1982)]. Beznoska (2014) stated that rise in prices of energy source such as fuel, gas as well as electricity affects badly the consumer welfare. So prices and income are the most important determinants of consumer welfare whose effect is never quantified in case of energy consumption for Pakistan.

Many previous studies explored the welfare effect of rising energy prices such as, Conrad and Schroder (1991); Davoodiand Salem (2007); Ahmadian, *et al*. (2007); Oktaviani, *et al*. (2007); Walawalkar, *et al*. (2008); Asghar, *et al*. (2010); Manzoor, *et al*. (2012); Huang and Huang (2012); Ememverdi, *et al*. (2012); Araghi and Barkhordari (2012); Ahmad, *et al*. (2013) and Beznoska (2014) for different countries and concluded that consumers adversely effected by the rise in petroleum product prices. But there is no relevant study for Pakistan that calculated welfare cost of energy consumption due to rising prices even we cannot find study that calculated price and expenditure elasticities for all energy sources simultaneously.

The purpose of this study is to calculate the welfare cost resulted from rising energy prices. In order to study the welfare cost, it is necessary to estimate the demand functions of main energy sources and then to calculate the change in welfare. The Linearised Almost Ideal Demand System (LA/AIDS) is used to estimate the demand functions while Compensating Variation (CV) measure is employed to assess the change in welfare resulted from the variations in energy product prices. Furthermore, this sort of study can be helpful for policy makers to know about the behaviour of energy consumers under different prices and income. As demand elasticity helps to forecast the future demand of energy sources under differential setting of price and income so this study will be an effort to achieve this target.

METHODOLOGY

Linear Approximation of Almost Ideal Demand System [presented by the Deaton and Muellbauer (1980a, 1980b)] is used to calculate the demand system for main eight energy sources. LA/AIDS is based on a particular form of the cost function and n-1 share equation w_i for utility maximising agents is calculated as following [Holt, *et al*. (2009)]

$$\omega_i = \alpha_i + \sum_{i=1}^{n} \gamma_{ij}\, lnp_j + \beta_i\, ln\left(\frac{x}{P}\right) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where P is price index

$$\ln P = \alpha_0 + \sum_{k=1}^{n} \alpha_k \ln p_k + \frac{1}{2}\sum_{k=1}^{n}\sum_{j=1}^{n} \gamma_{kj} \ln p_k \ln p_j \quad \ldots \quad \ldots \quad (2)$$

The original form of AIDS is not linearised in coefficients, which produce some complications not only in parameter estimation but also in the calculation of elasticities. So we applied the linear version (LA/AIDS) of the AIDS approach. In this version the price index is approximated by the linear function:

$$lnP = \sum_i \omega_i * ln(p_i) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

The LA/AIDS has following three restrictions of demand system such as: adding up across the share equations which can be achieved by dropping one out of the eight energy demand equations and estimate only seven share equations. The second is symmetry of the second-order derivatives and third one is linear homogeneity of degree zero which can be achieved by considering the price of other energy sources as constant and equating to 1.

$$\sum_{i=1}^{n} \alpha_i = 1, \quad \sum_{i=1}^{n} \gamma_{ij} = \sum_{j=1}^{n} \gamma_{ij} = 0, \; \sum_{i=1}^{n} \beta_i = 0, \; \gamma_{ij} = \gamma_{ji}$$

Marshallian, expenditure and Hicksian elasticities are estimated by the following expressions:

Marshallian (or uncompensated) elasticity:

$$\varepsilon_{ii} = -1 + {}^{\gamma_{ii}}/_{\omega_i} - \beta_i \qquad i = 1,\ldots,n$$

$$\varepsilon_{ij} = {}^{\gamma_{ji}}/_{\omega_i} - \beta_i \left({}^{\omega_j}/_{\omega_i}\right) \quad i,j = 1,\ldots,n;\ i \neq j$$

Expenditure (income) elasticity:

$$ή_i = 1 + {}^{\beta_i}/_{\omega_i} \, i = 1,\ldots,n$$

Hicksian (or compensated) price elasticity:

$$\delta_{ii} = -1 + {}^{\gamma_{ii}}/_{\omega_i} + \omega_i \qquad i = 1,\ldots,n$$

$$\delta_{ij} = {}^{\gamma_{ij}}/_{\omega_i} + \omega_i \, i,j = 1,\ldots,n;\ i \neq j$$

The FIML (Full Information Maximum Likelihood) method makes sure that the coefficients from the equations are independent to the excluded equation. Dummy variables are used to capture the unreliable facts and discontinuity of the data. Normally, the price or even income fluctuations usually not immediately and completely effect the energy market in the current year rather its influence will be felt above numerous periods and is dependent upon the situation of the preceding time interval. To overcome this problem, we established the lagged value of the expenditure share in each equation. The time series data (consumption and price) from 1987-2012 used in LA/AIDS model for Pakistan is mainly taken from energy year books, economic survey of Pakistan and World Bank statistics. Regarding the energy sources taken into account, we selected eight energy sources(including coal, gasoline, high speed diesel oil, kerosene oil, high octane blended component, compressed natural gas, natural gas and electricity).

Estimation of Compensating Variation

To estimate the compensating variation, the data on energy source consumption before price change and after price change is taken into consideration [Friedman and Levinsohn (2002)]. The general first order equation of CV may write as:

$$\Delta \ln c \approx \sum_{i=1} w_i \Delta \ln p_i \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

The substitution effect is not taken into account in first order approximation of compensating variation thus it produces the overestimated results. So to overcome this problem, CV can be approximated using a second order Taylor-series expansion. As second order approximation compensating variation contains compensated (Hicksian) elasticities so it produces more reliable results as compared to first order approximation by solving problem of substitution effect.

$$\Delta \ln c \approx \sum_{i=1} w_i \Delta \ln p_i + \frac{1}{2}\sum_{i=1}\sum_{j=1} w_i \varepsilon_{ij}^{*} \Delta \ln p_i \Delta \ln p_j$$

where, w_i is the budget share of energy source i in the initial period, Δ ln *pi* is proportionate change in the price of energy source *i*, and ε_{ij}^{*} is the compensated price elasticity of energy source *i* with respect to the price change of energy source *j*.

Inflation Scenarios

In the present study, the welfare change is measured in four different scenarios for Pakistan in order to analyse the impact of energy price change in different time span.

Scenario I	In this scenario, we analyse the impact of energy price change during 26 years (1987-2012) on consumer welfare of Pakistan.
Scenario II	In this scenario, we estimated the impact of energy price change in scenario of 7 years (1990-1996) on consumer welfare.
Scenario III	Since 2000, global oil prices have grown up but this rise has been seen extremely during 2003-2008 and international oil prices have risen by 347.6% [Tlhalefang and Galebotswe (2013)]. So, to measure the impact of global energy price shock occurred in 2008 on consumer welfare, the price change from 2003 to 2008 is taken in Pakistan.
Scenario IV	Tlhalefang and Galebotswe (2013) reported that during 2010-2013 international oil prices have risen by 68.6%. So, in this scenario the impact of oil price change on consumer welfare is measured by taking price change from 2009 to 2012.

3. ANALYSIS OF MAIN RESULTS

Empirical Results of Demand Equations

The results of estimations for different energy source demand for Pakistan are presented on Table 1 to 5 (see Appendix). The structural parametric coefficients of seven equations along with their standard error (in parenthesis) as well as significant levels are presented in Table 1. Positive as well as statistically significant expenditure coefficient values revealed that budget shares for each energy source increased along with rise in total energy spending and vice versa. The lag values of expenditure shares depicts that the current year expenditure share of energy sources is affected due to previous year expenditure shares of own energy source.

The variations in budget share of each energy source due to independent variables are measured by value of R-square which lies between ranges from 74 percent to 87 percent.

The estimated results of Hicksian short run elasticities are reported in Table 2. The diagonal values represent own price elasticities while cross price elasticities are shown by off diagonal values. The absolute value of own price elasticities of coal, gasoline, high speed diesel oil and natural gas are relative inelastic while High Octane Blended Component (HOBC), kerosene, CNG and Electricity are relative more elastic. Like short run, almost all the energy sources (except coal and natural gas) followed the same trend in the long run as well. It is clear from the results of Hicksian long run elasticity estimates reported in Table 3. Only gasoline and high speed diesel oil are relative less elastic in long run.

Table 4 represents the Marshallian and expenditure elasticities for main energy source of Pakistan. The last column of table represents the expenditure elasticity while rest of the columns provides the Marshallian elasticity corresponding to each energy source. It is clear from Table 4 that all own uncompensated (Marshallian) price elasticities for each energy source is negative which is consistent with consumer demand theory. The absolute values of uncompensated own-price elasticities of HOBC, kerosene, CNG, natural gas and electricity are more than unit. So these energy sources are relatively more price elastic while coal as well as gasoline are relatively less price elastic as the price elasticity of both energy sources is smaller than unit. Moreover, high speed diesel oil and natural gas is unit elastic.

Furthermore, it is clear from Table 4 that all energy sources have positive consumption expenditure elasticities excluding Kerosene and CNG, implying that all are "normal energy sources" except kerosene and CNG. While Kerosene as well as CNG is "inferior" as the expenditure elasticities are negative.

According to elasticities of substitution reported in Table 5, coal-CNG, natural gas-CNG and natural gas-HOBC are energy sources which are complement to each other while coal-gasoline, coal-HSD, gasoline-HSD, gasoline-CNG, HOBC-electricity, HSD-kerosene, HSD-natural gas, HSD-electricity, natural gas-electricity, electricity-kerosene as well as electricity-CNG are substitute to each other. The S shows that the energy sources are substitutes and C states that energy sources are complements.

Results of Compensation Variation

In this paper, the welfare cost is measured in first order as well as second order approximations. Through first order approximations the impacts of price changes on welfare is analysed by completely ignoring the response of households' behaviour in connection with price change. While the second order approximation produce the significant as well as appropriate measure of welfare cost [Banks, *et al*. (1996); McCulloch (2003); Niimi (2005); Nicitia (2004b); Friedman and Levinsohn (2002)]. In first order approximation, all the elasticities are considered to be zero so consumers are unable to change their consumption patterns due to price change. As the substitution effect is not taken into account for the first order approximation welfare analysis so this is the reason that it is considered to be seriously biased [Banks, *et al*. (1996)]. While through second order approximation full effect (including substitution effect), price change is analysed. Though, for comparison purpose, both first order as well as second order approximations results are stated in the present study. So estimated Hicksian (compensated) elasticities are utilised to quantify the welfare cost due to rising energy prices in four different scenarios. Following the previous studies [Niimi (2005); Nicitia (2004b); Friedman and Levinsohn (2002)], Compensating Variation (CV) technique is used to measure the change in consumer welfare.

The following Tables 6 and 7 represent the CV estimates, as a percentage of average consumer expenditure, for each energy source based on their budget share and price change in distinctive scenarios for Pakistan. For comparison purposes, we also presented estimates from a fist-order approximation to the price changes, which disregards substitution effects in consumption. The Table 6 presents the first-order effects while Table 7 shows the full effects. It is clear from Table 6 that in Scenario I the consumer required 289 percent of their total expenditure (per year) to compensate the consumers' income to reach at initial utility level due to higher energy prices, without allowing for substitution to relatively cheap energy source. At disaggregate level, 149.79 percent of total expenditure as compensation (per year) is required to attain 1987s' consumption pattern in case of high speed diesel oil. Similarly, CNG consumer needs 0.01 percent compensation to maintain the initial consumption level. Furthermore, natural gas and electricity consumer required 9.9 percent and 43 percent respectively as compensation respectively. While in Scenario II, 84.24 percent of total expenditure (annually) is needed to pay the consumer to achieve the 1990s' utility level as a result of increase in energy prices which they faced during 7 years. Furthermore, at disaggregate level, high speed diesel oil consumer required 32.92 percent of total expenditure as compensation (per year) to attain 1990s' consumption level. Correspondingly, gasoline consumer required 13.75 percent compensation to maintain the initial consumption level. While, natural gas and electricity consumer required 2.62 percent and 25.75 percent respectively as compensation to reach at initial utility level without substitution. In scenario III, 67.24 percent of total expenditure (per year) is necessary to pay the consumer to achieve the 2003s' utility level which they faced during 6 years without allowing for substitution. While at disaggregate level, in case of high speed diesel oil 44.85 percent of total expenditure as compensation (per year) is required to attain initial consumption level. Correspondingly, gasoline consumer required 10.39 percent compensation to maintain the earlier consumption level. Furthermore, natural gas and electricity consumer required 3.58 percent and 6.38 percent respectively as compensation to reach at initial utility level without substitution. In Scenario IV, 52.19 percent of total expenditure (per year) is necessary to pay the consumer to achieve the 2009s' utility level as a result of increase in energy prices which they faced during the scenario of 4 years without allowing for substitution. While for high speed diesel oil 29.22 percent of total expenditure as compensation (per year) is required to attain initial consumption level. Correspondingly, gasoline consumer required 6.18 percent compensation to maintain the earlier consumption level. Furthermore, natural gas and electricity consumer required 5.79 percent and 13.75 percent respectively as compensation to reach at initial utility level.

Table 7 represents CV including substitution effect that is considerably smaller than the estimates without the substitution effect and it is clear from Table 3.2. But this situation is opposite in the long scenario of 26 years as in the long run the substitution effects also contributes in the welfare loss. While in scenario II when we considered the substitution effect, compensating Variation declines from 84.24 percent to 78.30 percent. Scenario III covers the oil shock occur during 2003-2008. In this scenario welfare also declines as a result of energy inflation. As the average consumer of Pakistan needs 36 percent compensation on their total expenditures to attain the consumption level that they enjoy in 2003. While in scenario IV, 52.59 percent of total expenditure is required to attain the consumption level of 2009.The overall results suggest that all household groups suffered welfare lost arising from the energy price increases in all scenarios.

Table 6

First order estimation of Compensation Variation

Energy Sources	Scenario I	Scenario II	Scenario III	Scenario IV
Coal	12.42	2.18	1.66	1.91
Gasoline	60.24	13.75	10.39	6.18
HOBC	13.16	6.98	-0.034	0.009
Kerosene	0.05	0.01	0.0029	0.002
High Speed Diesel Oil	149.79	32.92	44.85	29.22
CNG	0.01	0.0002	0.39	1.90
Natural Gas	9.89	2.62	3.58	5.79
Electricity	43.11	25.75	6.38	13.75
Total	288.70	84.24	67.24	58.76

Source: Authors' own calculations.

Table 7

Second Order Estimation of Compensation Variation

Scenario I	Scenario II	Scenario III	Scenario IV
326.38	78.30	63.03	52.59

Source: Authors' own calculations.

DISCUSSION

Unfortunately, there are very few studies in Pakistan which estimate the energy demand at disaggregate level to capture the demand elasticities for coal, gas, gasoline, electricity, diesel, kerosene, CNG and HOBC such as Burney and Akhtar (1990); Malik, (2008); Khan and Ahmad (2008); Akmal, (2002); Chaudhry, *et al*. (2012).

Electricity is considered to be essential energy source in Pakistan. So, in the present study, in accordance our results the demand for electricity is essential and the same results are found in Akmal (2002); Khan and Ahmad (2008). But price elasticity of electricity is not less responsive to electricity price contrary with Siddiqui (1999); Khan and Ahmad (2008); Iqbal, *et al*. (2013) but similar to Chaudhry, *et al*. (2012) conclusions. Coal is also essential energy source according to present study and also Khan and Ahmad (2008) supports our finding. In addition it, price elasticity of coal is less responsive to coal price following to Siddiqui (1982).

Since 1980s' natural gas is considered as a big source to provide energy in manufacturing sector as well as to generate electricity [Siddiqui (1999)]. Moreover, the natural gas consumption share in Pakistan is more than 50 percent (Pakistan (2012)]. According to present study the natural gas is essential energy source and this result is consistent with Iqbal (1983); Siddiqui and Haq (1999); Khan and Ahmad (2008) results. So, its demand responses as price change. Our results suggest that demand for natural gas responses more to price change of natural gas which is inconsistent with Iqbal (1983); Siddiqui and Haq (1999); Khan and Ahmad (2008) results. In addition to it, electricity or coal is alternatives of natural gas which is similar with Siddiqui (1999) results.

In transport sector, gasoline as well as high speed diesel is mainly used while kerosene is mostly used by domestic sector. The demand for High Speed Diesel Oil is affectedly increased as a result of low taxes on HSD on the other hand gasoline prices tend to rise due to higher taxes on gasoline prices. Furthermore, rising CNG demand in transport sector also affect the gasoline demand [Ahmad and Kumar (2007)]. So, in present study the demand for HSD is essential, gasoline is superior according to our results and finally CNG is inferior due to less improvement in vehicles' efficiency. Moreover, HOBC and Kerosene is superior and inferior respectively in the present study. Furthermore, our results suggest the substitution among gasoline-HSD and gasoline-CNG and gasoline-coal (but not close substitute) and these results support the Chaudhry, *et al*. (2012) conclusion as well as electricity and kerosene are alternatively used in domestic sector similar with Siddiqui (1999) findings.

The gasoline energy source is found to be less responsive to gasoline price in present study similar with Ahmadian, *et al*. (2007); Burney and Akhtar (1990). Finally, it is easy to say that in present study, the demand for energy in most cases is price responsive and variation in income causes the change in energy demand similar with Siddiqui and Haq (1999) findings.

Unfortunately, there are no studies which made efforts to estimate the consumers' compensating variation measure of energy consumption pattern due to rising energy prices at disaggregate level in Pakistani energy market. But very few studies are conducted to quantify the welfare implications as a result taxation and shortage of energy supply such as Ahmad, *et al*. (2013); Ali and Nawaz (2014). The present study estimates that due to growing energy prices, especially in inflationary scenarios, the consumers' welfare fall, and compensating variation cost is required to compensate the consumers' income to recover the earlier consumption pattern. These findings are consistent with Davoodi and Salem (2007); Asghar, *et al*. (2010); Nikban and Nakhaie (2011); Araghi and Barkhordari (2012); Ahmadian, *et al*. (2007) studies conducted in Iran, Huang and Huang (2012) conducted in US.

CONCLUSION

The results of the AIDS demand system for energy sources confirmed that higher energy prices have an adverse impact toward consumers' welfare in Pakistan. From the elasticities it is concluded that coal, high speed diesel oil, natural gas as well as electricity is considered to be necessity[1] energy source in Pakistan, moreover the demand elasticities also confirmed the nature of these energy sources as these are relatively less elastic or unit elastic. While in case of kerosene and Compressed Natural Gas, the demand elasticities were relatively more elastic that explained the inferior[2] energy source.

Furthermore, It is concluded from the measure of compensating variation in four scenarios that when energy prices increase inadequately, consumer required more amount of total expenditure in term of percentage (per year) as a compensation to recover/attain the initial consumption pattern, without allowing the substitution. But when consumers are allowed to move to inexpensive energy source then the measure of compensation is significantly smaller. While in case of scenario of 25 years the amount of compensation with substitution remains higher as compared to measure of compensation without substitution.

The results of the present study are important for policy-maker to modify the price as well as income policies. In order to propose effective energy pricing policy for future, the present study will be helpful and both public and private investors can get benefits for future decision from this study. In case of relatively price elastic energy source, as price rise then consumers demanded less for energy source. In this situation policy maker should adopt price control policy to enhance the energy consumption. As natural gas is essential energy source in Pakistan and relatively elastic too in the present study. So, in order to control its consumption, price control policy should be adapted by policy makers. Unfortunately, Pakistan is facing the shortage of natural gas. The awareness should be prevailed among consumers for efficiently utilisation of energy sources in order to overcome the problem of shortage of energy. Electricity is considered to be a secondary source of energy in Pakistan. In developing countries like Pakistan oil is used to generate the electricity. As Pakistan is importer of oil so, Pakistan's electricity generation is extremely influenced by imported oil seeing that every year about 14.5 billion dollar is spent to import oil in Pakistan, the mostly oil is used for electricity generation [Pakistan (2013)]. As electricity is also essential and relatively price elastic energy source in Pakistan. So, price control policy is benefit to control the consumption level. The electricity prices are badly affected due to any disturbance in global oil prices. So, Pakistan should decrease the dependency on imported oil to generate electricity. Pakistan should invest in coal, natural gas as well as electricity generation in order to decrease the import bill.

[1]Because the expenditure elasticity for coal, high speed diesel oil, natural gas and electricity is less than zero which implying the essential energy source.

[2]As the expenditure elasticity of kerosene as well as CNG is negative indicating the inferior energy sources.

APPENDIX

Table 1

Coefficients of Shares Equations for Pakistan

Independent Variables	Gasoline	HOBC	Kerosene oil	HSD	CNG	Natural Gas	Electricity
	Dependent Variables						
Constant	-0.577*	-0.030	-0.09***	2.307***	-0.150*	-0.057	-0.86***
	(0.343)	(0.118)	(0.031)	(0.369)	(0.087)	(0.038)	(0.250)
Coal	0.003	0.000	0.001	-0.034**	0.003	-0.002**	0.011
	(0.012)	(0.005)	(0.001)	(0.016)	(0.004)	(0.001)	(0.007)
Gasoline	0.117***	-0.024**	-0.001	-0.074**	-0.006	-0.01***	-0.009
	(0.033)	(0.011)	(0.003)	(0.034)	(0.008)	(0.004)	(0.024)
HOBC	-0.048***	-0.005	-0.003**	0.050***	-0.01***	0.003*	0.024**
	(0.013)	(0.004)	(0.001)	(0.014)	(0.003)	(0.001)	(0.009)
Kerosene	0.091	0.047**	0.012**	-0.067	0.021	0.004	-0.071*
	(0.057)	(0.019)	(0.005)	(0.061)	(0.014)	(0.006)	(0.042)
HSD	-0.053	0.004	-0.003	0.059	0.002	-0.02***	-0.032
	(0.069)	(0.023)	(0.006)	(0.072)	(0.017)	(0.008)	(0.050)
CNG	0.007	0.008	0.007**	0.024	0.013	-0.003	-0.049*
	(0.035)	(0.012)	(0.003)	(0.037)	(0.008)	(0.004)	(0.025)
Natural Gas	-0.063***	-0.013*	-0.01***	0.025	-0.005	0.053***	0.030**
	(0.021)	(0.007)	(0.002)	(0.022)	(0.005)	(0.002)	(0.015)
Electricity	-0.045***	-0.03***	0.003	-0.05***	-0.003	-0.01***	0.173***
	(0.013)	(0.004)	(0.001)	(0.014)	(0.003)	(0.002)	(0.009)
Cost_deflat	-0.215 ***	-0.09***	-0.02***	0.44 ***	-0.025	-0.018**	-0.09*
	(0.076)	(0.026)	(0.006)	(0.082)	(0.019)	(0.009)	(0.056)
Lag	0.164***	0.263***	-2.13***	0.059***	0.027**	0.113***	0.085***
	(0.009)	(0.012)	(0.078)	(0.009)	(0.010)	(0.009)	(0.008)
dum_00_01	0.005	0.001	–	-0.006	-0.002	–	–
	(0.010)	(0.005)		(0.017)	(0.004)		
dum_03_06	-0.006	-0.003	–	0.012	0.001	–	–
	(0.007)	(0.003)		(0.011)	0.002		
R-Square	0.82	0.80	0.74	0.89	0.83	0.81	0.87
Adjusted R-square	0.64	0.59	0.57	0.77	0.74	0.62	0.76

Source: Authors' own calculations.

*** Indicates significant at 1 percent level of significance.

** Indicates significant at 5 percent level of significance.

* Indicates significant at 10 percent level of significance.

Note: For each pair of estimates, the upper figure is the estimated parameters, and the lower figure in parenthesis is the standard error.

Table 2

Hicksian Short Run Elasticities

Prices	Coal	Gasoline	HOBC	HSD	Kerosene	CNG	Natural Gas	Electricity
	Energy Consumption							
Coal	-0.582	0.340	-0.384	0.423	-0.170	-0.218	-0.550	1.14
Gasoline	0.298	-0.791	-0.186	0.485	0.002	0.052	0.049	0.30
HOBC	0.131	18.410	-1.569	0.735	1.048	-0.095	-0.42 9	0.05
HSD	0.045	0.142	-0.046	-0.554	0.001	0.005	0.064	0.26
Kerosene	-14.6	-19.30	-17.854	22.981	-35.675	7.002	6.455	1.66
CNG	-0.360	0.495	5.843	-0.287	-0.031	-1.447	-0.294	0.29
Natural Gas	8.178	-2.733	-0.372	0.609	-0.029	0.011	-0.899	1.03
Electricity	-0.432	-0.654	0.261	0.369	-0.023	0.042	0.101	-1.05

Source: Authors' own calculations.

Table 3

Hicksian Long Run Elasticities

	Energy Consumption							
Prices	Coal	Gasoline	HOBC	HSD	Kerosene	CNG	Natural Gas	Electricity
Coal	**-1.401**	0.702	-0.792	0.873	-0.351	-0.451	-1.135	2.356
Gasoline	0.299	**-0.796**	-0.187	0.488	0.002	0.052	0.050	0.305
HOBC	0.131	18.461	**-1.574**	0.737	1.051	-0.095	-0.430	0.048
HSD	0.045	0.141	-0.046	**-0.557**	0.001	0.005	0.0646	0.261
Kerosene	-11.2	-18.37	-17.673	22.749	**-35.913**	6.931	6.833	1.646
CNG	-0.375	0.515	6.087	-0.299	-0.032	**-1.507**	-0.307	0.311
Natural Gas	8.292	-2.771	-0.377	0.618	-0.029	0.011	**-1.013**	1.045
Electricity	-0.432	-0.654	0.261	0.369	-0.024	0.041	0.101	**-1.049**

Source: Authors' own calculations.

Table 4

Expenditure and Marshallian Elasticity

	Consumption								
Prices	Coal	Gasoline	HOBC	HSD	Kerosene	CNG	Natural Gas	Electricity	
Coal	**-0.61**	0.179	-0.405	0.018	-0.170	-0.23	-0.596	0.90	0.907
Gasoline	0.26	**-0.87**	-0.211	0.015	0.002	0.041	-0.005	0.034	1.052
HOBC	0.09	18.245	**-1.59**	0.317	1.048	-0.105	-0.478	-0.19	1.004
HSD	0.01	-0.034	-0.07	**-0.98**	0.001	-0.005	0.013	0.01	0.991
Kerosene	-11.4	-18.02	-17.68	26.21	**-35.68**	7.078	6.829	3.51	-7.23
CNG	-0.36	0.504	5.84	-0.265	-0.031	**-1.45**	-0.292	0.31	-0.04
Natural Gas	8.169	-2.781	-0.37	0.487	-0.029	0.008	**-1.01**	0.96	0.273
Electricity	-0.46	-0.831	0.23	-0.077	-0.024	0.031	0.049	**-1.60**	0.944

Source: Authors' own calculations.

Table 5

Elasticity of Substitution

	Energy Consumption							
	Coal	Gasoline	HOBC	HSD	Kerosene	CNG	Natural Gas	Electricity
Coal		S	C	S	C	C	C	S
Gasoline	S		C	S	S	S	S	S
HOBC	S	S		S	S	C	C	S
HSD	S	S	C		S	S	S	S
Kerosene	C	C	C	S		S	S	S
CNG	C	S	S	C	C		C	S
Natural Gas	S	C	C	S	C	C		S
Electricity	C	C	S	S	S	S	S	

*Source:*Authors' own calculations.

REFERENCES

Ahmad, A. and M. Kumar (2007) Status of Petroleum Sector in Pakistan: A Review. 27:3, 15–35.

Ahmadian, M., M. Chitnis, and L. C. Hunt (2007) Gasoline Demand, Pricing Policy and Social Welfare in Iran.(Surrey Energy Economics Discussion Paper Series No. 117).

Ahmed, E., A. Jalil, and M. Idrees (2013) Almost Ideal Demand System and Uniform Taxation in Pakistan: Econometric Evidences for Consumer Goods in Pakistan, 1984–2008. *Applied Econometrics and International Development* 13:2, 207–216.

Akmal, M. (2002) The Structure of Consumer Energy Demand in Australia: An Application of a Dynamic Almost Ideal Demand System. In 2002 Conference (46th), February 13-15, 2002, Canberra (No. 125050). Australian Agricultural and Resource Economics Society.

Ali, H. and M. Nawaz (2014) Energy Crisis and Production Inefficiency: Micro-evidence from Textile Sector of Faisalabad. 56:14, 42–65.

Araghi, K. M. and S. Barkhordari (2012) An Evaluation of the Welfare Effects of Reducing Energy Subsides in Iran. *Energy Policy* 47, 398–404.

Asghar, S., M. Mehrara, and N. Fayazi (2010) Energy Prices Increase, Welfare, and Government Expenditure: An Input-output Model. *Iranian Economic Research*14:42, 1–2.

Azarbaiejani, K., A. S. Hamedani, and M. Bahaloo (2012) An Analysis of the Effect of Energy Subsidies Decrease and Transfer Payment to Households on Social Welfare in Iran. *Interdisciplinary journal of Contemporary Research in Business* 4:1, 1–11.

Banks, J., R. Blundell, and A. Lewbel (1996) Tax Reform and Welfare Measurement: Do We Need Demand System Estimation? *Economic Journal* 106:438, 1227–1241.

Beznoska, M. (2014) Estimating a Consumer Demand System of Energy, Mobility and Leisure: A Micro Data Approach for Germany. (DIW Berlin Discussion Paper No. 1374).

Burney, N. A. and N. Akhtar (1990) Fuel Demand Elasticities in Pakistan: An Analysis of Households' Expenditure on Fuels Using Micro Data. *The Pakistan Development Review* 29:2, 155–174.

Chaudhary, I. S., N. Safdar, and F. Farooq (2012) Energy Consumption and Economic Growth: Empirical Evidence from Pakistan. *Pakistan Journal of Social Sciences* 32:2, 371–382.

Conrad, K. and M. Schroder (1991) Demand for Durable and Nondurable Goods, Environmental Policy and Consumer Welfare. *Journal of Applied Econometrics* 6, 271–286.

Davoodi, A. and J. Salem (2007) The Effect of Increase in Petroleum Price on Welfare of Various Income Groups in Persian. *Economic Researches* 23, 15–48.

Deaton, A. and J. Muellbauer (1980a) *Economics and Consumer Behaviour*. Cambridge: Cambridge University Press.

Deaton, A. and J. Muellbauer (1980b) An Almost Ideal Demand System. *American Economic Review* 70, 312–326.

Ememverdi, G., M. Farahani, A. M. Tazekandi, and R. Haftlang (2012) Effect of Energy Carries Prices on Welfare Measurement Indexes. *Journal of Basic and Applied Scientific Research* 2:1, 795–801.

Erbaykal, E. (2008) Disaggregate Energy Consumption and Economic Growth: Evidence from Turkey. *International Research Journal of Finance and Economics* 20, 172–179.

Friedman, J. and J. A. Levinsohn (2002) The Distributional Impact of Indonesia's Financial Crisis on Household Welfare: A Rapid Response Methodology. *World Bank Economic Review*16:3, 397–423.

Haider, A., Q. M. Ahmed, and Z. Jawad (2013) *Determinants of Energy Inflation in Pakistan: An Empirical Analysis.* Karachi: Institute of Business Administration.

Holt, M. T. and B. K. Goodwin (2009) The Almost Ideal and Translog Demand Systems. *Contributions to Economic Analysis* 288, 37–59.

Huang, K. S. and S. W. Huang (2012) Consumer Welfare Effects of Increased Food and Energy Prices. *Applied Economics* 44:19, 2527–2536.

Iqbal, M. (1983) Residential Demand for Electricity and Natural Gas in Pakistan. *The Pakistan Development Review* 22:1, 23–36.

Iqbal, N., S. Nawaz, and S. Anwar (2013) Electricity Demand in Pakistan: A Nonlinear Estimation. Pakistan Institute of Development Economics, Islamabad. (Mimeographed).

Khan, M. A. and U. Ahmad (2008) Energy Demand in Pakistan: A Disaggregate Analysis. *The Pakistan Development Review* 47:4, 437–455.

Kolev, A. and A. Riess (2007) Energy: Revival of a Burning Matter. (EIB Papers No. 12). 10–28.

Malik, A. (2008) Crude Oil Price, Monetary Policy and Output: The Case of Pakistan. *The Pakistan Development Review* 47:3, 425–43.

Malik, A. (2008) How is Pakistan Coping with the Challenge of High Oil Prices? *The Pakistan Development Review* 47:4, 25–45.

Manzoor, D., A. Shahmoradi, and I. Haqiqi (2012) An Analysis of Energy Price Reform: A CGE Approach. *OPEC Energy Review* 36:1, 35–54.

McCulloch, N. (2003) The Impact of Structural Reforms on Poverty: A Simple Methodology with Extensions. World Bank. (Policy Research Working Paper 3124).

Nicita, A. (2004b) Efficiency and Equity of a Marginal Tax Reform: Income, Quality and Price Elasticities for Mexico. World Bank. (Policy Research Working Paper 3266).

Niimi, Y. (2005) An Analysis of Household Responses to Price Shocks in Vietnam: Can Unit Values Substitute for Market Prices? University of Sussex. (Poverty Research Unit Working Paper No. 30).

Nikban, A. and H. Nakhaie (2011) Evaluation of Consumers' Welfare Costs Due to Rise of Energy Carriers Prices. *International Proceedings of Economics Development and Research* 12.

Oktaviani, R., D. B. Hakim, and S. Siregar (2007) Impact of a Lower Subsidy on Indonesian Macroeconomic Performance, Agricultural Sector and Poverty Incidences: A Recursive Dynamic Computable General Equilibrium Analysis. (MPIA Working Paper 2007-2008).

Pakistan, Government of (Various Issues). *Economic Survey of Pakistan*. Islamabad: Government of Pakistan, Finance Division, Economic Advisor's Wing.

Pakistan, Government of (Various Issues). *Pakistan Energy Yearbook*. Islamabad: Hydrocarbon Development Institute of Pakistan, Ministry of Petroleum and Natural Resources, Government of Pakistan.

Rai, G. D. (2004) *Non-conventional Energy Sources*. Delhi: Khanna Publishers.

Ramchandra, P. and D. Boucar (2011) Green Energy and Technology. World Bank. (Policy Research Working Paper 3364).

Siddiqui, R. (1982) An Analysis of Consumption Pattern in Pakistan. *The Pakistan Development Review* 21, 275–96.

Siddiqui, R. (1999) Demand for Energy and the Revenue Impact of Changes in Energy Prices. (Working Papers and Research Reports, RR-No. 117).

Siddiqui, R. and R. Haq (1999) Demand for Energy and the Revenue Impact of Changes in Energy Prices. Pakistan Institute of Development Economics, Islamabad. (Research Report No. 174).

Thoresen, P. E. (1982) Oil Price and Inflation. *Energy Economics* 4, 121–126.

Tlhalefang, J. and O. Galebotswe (2013) Welfare Effects of Higher Energy and Food Prices in Botswana: A SAM Price Multiplier Analysis. *Botswana Journal of Economics* 11:15.

Walawalker, R., S. Blumsack, J. Apt, and S. Fernands (2008) An Economic Welfare Analysis of Demand Response in the PJM Electricity Market. *Energy Policy* 36, 3692–3702.

World Bank (n.d.) *World Bank Development Indicators*, Population Statistics. Retrieved from http://data.worldbank.org/indicator/SP.POP.TOTL.