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# WELFARE ANALYSIS OF ENERGY PRICE VARIATIONS IN PAKISTAN

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**Abstract**. This study analyzes the impact of energy price variations on households' welfare in rural and urban areas of Pakistan. Welfare implications of energy price changes are drawn from the estimation of compensating variation associated with simulated energy price increases. For this purpose, an Almost Ideal Demand System (AIDS) is estimated with pooled data of Household Integrated Economic Survey (HIES) over the period 1985 to 2013. The econometric analysis shows that welfare losses resulting from energy price inflation in Pakistan have been substantial. Further, the energy prices in Pakistan have been somewhat regressive. Based on these findings and the consideration that poor households are relatively more vulnerable to energy prices increase, the study proposes to extend a compensation package to poor households in the light of rising energy prices. It is shown that the budgetary impact of the required subsidy would be moderate and can be realized by exempting poor households from certain levies and taxes.

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This paper is based on MPhil thesis of Muhammad Atta ul Islam Abrar supervised by Eatzaz Ahmad. The paper is extended by Eatzaz Ahmad and Ghulam Saghir to estimate the welfare effects of energy price changes at different income quintiles and to include in this estimation the indirect (spillover) effect of energy price inflation on non-energy price inflation.

**Keywords**: Welfare analysis, energy price variations, budgetary impact, compensating variation , almost ideal demand system

## I. INTRODUCTION

Energy is an important consumption item both in developed and developing countries. As of the year 2014, per capita energy consumption in Pakistan is 460 kg of oil equivalent compared to South Asian average of 574 kg and global average of 1922 kg.2 In a country like Pakistan where electrification of the rural sector is not yet complete, besides electricity and natural gas, other forms of energy like kerosene, coal and firewood still remain important components of household consumption basket, especially in rural areas.

Governments in the modern era have acknowledged energy as one of the basic needs and this realization has led many countries, specifically the developing ones, to establish such energy pricing policies that would benefit consumers at large and would make energy affordable for low income groups. However, due to the rapid increase in oil prices internationally until the recent years, large balance of payments and budget deficits have forced them to revisit the policies regarding energy subsidies. Until quite recently, electricity and natural gas were available on highly subsidized rates in Pakistan. However, taking into account the fiscal pressures and crowding out of high priority public spending, particularly on infrastructure, health and education, the subsidies on energy have been reduced substantially in the recent years.

Energy prices directly and indirectly affect households' real incomes. The increase in real disposable income due to payment of lower prices by households for consumption of energy products is termed as the direct effect. The indirect effects can be noticed in the payment of lower prices by households for other goods and services that are reflected in lower costs of energy-based production inputs.

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[2] Source: *Databank* of World Development Indicators.

The opponents of energy subsidy argue that these are inequitable as well as inefficient and also encourage overconsumption (International Monetary Fund, 2013). Another problem is that most of the benefits of lower energy prices go to the groups who have higher incomes and consume more fuel (Arze et al., 2010). Recognition of these factors has led to changes in energy pricing policies mostly in the form of reduction or removal of subsidies.

Various governments in Pakistan have allocated generous subsidies on energy. During 2004 to 2010 fuel subsidy on average accounted for 1.12% of GDP (Vagliasindi, 2013). The total amount of subsidies extended to energy sector in the last five years was Rs.1250 billion (IMF, 2013). Despite the government's intentions to effectively target vulnerable groups of society; rich consumers, commercial consumers and some categories of industrial consumers have also been reaping the benefits. In this regard, the IMF has advised the Government of Pakistan several times to bring reforms in the energy pricing policy and cut down subsidies, being inefficient and untargeted (Mills, 2012).The reduction in subsidies and rising domestic prices of energy products affect the welfare of households in two ways (Arze, et al., 2010). One is a direct effect in the form of increased prices of electricity and fuels. The other one is the indirect effect that the households face in the form of increased prices of other goods and services, reflected in increased costs of production.

Due to the prevailing energy situation in Pakistan, many researchers have analyzed energy prices in search of the possible causes and solutions of energy crisis. Most of the researchers have addressed the energy demand and energy supply issues (Burney and Akhtar, 1990; Hathaway, 2007; Jamil and Ahmad, 2010, 2011; Khan and Ahmed, 2009). The issue of energy pricing policy, energy subsidies reforms and its consequences on welfare of consumer has only recently been addressed. An earlier study by Ashraf and Sahih (1992) finds that electricity prices in Pakistan have been considerably different from the second best optimal prices. However, the focus of this study has been on efficiency rather that welfare of the consumers of electricity. Abrar (2015) considers welfare implications of energy prices on the average (representative) consumer and finds that the welfare loss in substantial. The present study is extracted from this thesis with some two extensions. First the welfare effects are estimated for average consumer as well as for the representative consumers at different quantiles of income. Second, the study considers direct welfare effect of energy price changes as well as the indirect effect that occurs due to spillover inflationary effect of energy price changed on prices of non-energy goods. Another similar recent study by Aziz et al. (2016) that estimates welfare effects of energy price changes suffers from two serious problems. First, it estimates 13 parameters for share equation using only 26 observations, which makes the results highly unreliable. Secondly, the entire exercise considers energy products only and excludes the role of prices of non-energy goods. Since no substitution between energy and non-energy goods is allowed, the welfare effects of energy price increases are expected to be overestimated.

The main objective of the present study is to analyze the impacts of energy price changes (increase or decrease in energy prices) on consumer's welfare in Pakistan. The paper does not analyze energy price shocks, as done in macroeconomics literature, n does it analyze any specific energy pricing policies; it analyzes scenarios for systematic price variations. This is so because energy prices in Pakistan are driven by a number of factors, including world prices, donors' conditionalities, revenue collection, regulations to stabilize general price level and sector-specific targets. It is quite unrealistic to either identify the role of specific policies in the realized energy prices or to label all energy price changes as policies.

The study will be conducted for both Rural and urban consumers. The welfare analysis is derived from household demand functions based on the well-celebrated Almost Ideal Demand System (AIDS), which not only satisfies almost all the theoretical properties of demands but is also flexible enough to capture the observed data reasonably well. Once the demand system is estimated, it is possible to obtain the Indirect Utility Function and, hence, the Expenditure Function. Then in the final step, it is possible to estimate the expected changes in household expenditure in response to changes in prices of any goods or services in the system, while holding constant the level of household's satisfaction (utility). This change is expenditure to satisfy a given level of satisfaction is the compensating variation (CV), which is a correct measure of welfare gain or loss resulting from price changes. The CV measures the welfare change of a consumer due to price changes, while allowing for the possible adjustment in consumption pattern in response to price changes. For example, if a consumer is able to avoid the effect of increase in electricity price by reducing electricity consumption, while maintaining the perceived level of satisfaction constant, the CV variation will show a smaller amount of welfare loss as compared to the increase in expenditure to buy a given basket of goods including electricity.

Although the above analytical framework is well known in welfare economics, its use has not been found in empirical literature on the welfare effects of energy price changes. In particular, no empirical study has been undertaken to formally estimate the welfare cost energy price changes in Pakistan. Welfare analysis in the present study is conducted separately for the rural and urban households by simulating the effects of one to 100 percent increases in the prices of energy goods on welfare level of an average household at the sample mean. This exercise is carried out first by holding the prices of all the non-energy goods constant and then by incorporating the spillover inflationary effect of energy price increases on the non-energy prices estimated through an auxiliary equation.

Finally, to draw distributional implications of energy price changes, the study estimates the above-mentioned welfare loss for an average representative consumer as well as for the relatively poor and rich consumers placed at the first and the fourth quintiles of total expenditure (taken as a proxy of income).

Main conclusion of the study is that energy price inflation has resulted in a substantial welfare loss both for rural and urban households of Pakistan and the energy pricing policy in Pakistan has been regressive in nature in the sense that the welfare loss in percentage terms has been somewhat higher among the poor households than among the rich households. Based on these results and other considerations the study recommends in favor of a compensation package exclusively for poor households to enable them face the burden of energy price inflation. The calculations show that if, for example, all the 20% poorest households are protected against 25% increase in energy prices then the impact of the subsidy would be about 0.2% GDP and a simple way out to finance the subsidy would be to exempt the poor households from certain categories of levies and taxes.

The study is organized in five sections. Section 2 provides a brief review of literature. Section 3 presents household demand model to be estimated, while section 4 explains the methodology employed for estimating the welfare effects of energy pricing policies. Section 5 describes data and variables to be used. The results are presented and discussed in section 6 and finally section 7 concludes the study.

## II. SURVEY OF LITERATURE

The main reason, due to which energy pricing has become an issue in major public policy and has attracted many researchers and policy makers, is its cost. Subsidized energy has contributed to fiscal deficits that are hardly sustainable. Price controls once adopted are difficult to roll back and become persistent. Phasing-out of such controls later becomes much difficult for policy makers in the face of opposition. Literature on the specific subject of energy pricing is available in abundance.

Energy pricing policy is important not only as a burning issue in economics but also in the context of environment, long run sustainability of natural resources and social dimension of the provision of basic needs to the poor. This is perhaps the main reason why the subject of energy pricing attracts attention in non-academic circles as much as in academic ones and a large variety of research tools are being used to address the issue depending on focus of the analysis. One can see all strands of research methods and designs such as pure qualitative research, descriptive statistical analysis, micro and macro econometric techniques, input-output analysis, dynamic CGE analysis, etc.

A brief summary of selected literature on energy pricing is presented in Table 1. The table shows that researchers in all regions of the world have addressed this issue. Most of the researchers and policy makers tend to criticize governments on the extension of universal energy subsidies to consumers, as their studies show that untargeted energy prices are inefficient as they result in over consumption of energy and crowd out high priority government spending. Though most of the studies find that increase in energy prices would cause real income inequitable, contrary evidences are not uncommon. A few studies do favor energy price regulation but recommend its proper targeting in order to fully achieve the proposed objectives of energy price regulation (e.g. Frondel et al., 2006). In any case, the majority of the studies recommend governments to phase-out energy subsidies for one reason or the other (e.g. Arze et al., 2010; Vagliasindi, 2013; Mills, 2012).

TABLE 1

Summary of Literature on Energy Demand and Pricing Policies

| Study | Countries | Data Type | Methodology | Results/Conclusions |
|---|---|---|---|---|
| Abrar (2015) | Pakistan | Pooled household survey data | AIDS | • Energy price reduces consumes' welfare substantially.<br>• The welfare loss is higher in rural areas as compared to urban areas. |
| Adagunodo (2013) | Nigeria | Households surveys data | AIDS | • Low marginal social and welfare costs of energy products suggest that removing of energy subsidy and price reforms will free large amount of funds for government expenditures. |
| Ahmadian *et al.* (2007) | Iran | Annual macro time series data | Structural time series model | • Social welfare decreases due to higher gasoline prices, which can be partially offset by changes in other variables. |
| Anand *et al.* (2013) | India | Annual, time series macro data | Descriptive | • Fuel subsidies are badly targeted because the richest 10% percent households are receiving 7 times more benefits than the poorest 10%.<br>• Subsidy reform will generate large fiscal savings, while real incomes of households will be lowered due to increases in fuel and other prices.<br>• Better targeted fuel subsidies will protect lower income groups and will still generate large fiscal savings. |
| Abrar (2015) | Pakistan | Pooled household survey data | AIDS | • Energy price reduces consumes' welfare substantially.<br>• The welfare loss is higher in rural areas as compared to urban areas. |
| Adagunodo (2013) | Nigeria | Households surveys data | AIDS | • Low marginal social and welfare costs of energy products suggest that removing of energy subsidy and price reforms will free large amount of funds for government expenditures. |
| Ahmadian *et al.* (2007) | Iran | Annual macro time series data | Structural time series model | • Social welfare decreases due to higher gasoline prices, which can be partially offset by changes in other variables. |
| Aziz *et al.* (2016) | Pakistan | Time Series data | AIDS | • When energy prices increase inadequately, consumers need to |

| Study | Countries | Data Type | Methodology | Results/Conclusions |
|---|---|---|---|---|
| | | | | be compensated.<br>• If consumers substitute towards inexpensive energy sources, compensating variation gets much smaller. |
| Breisinger *et al.* (2011) | Yemen | Households Survey data | CGE model | • Efficiency gains from petroleum subsidies reform are likely to accelerate economic growth from 0.1 to 0.8 percentage points annually.<br>• If other measures along with reform are not taken, poverty will increase in both urban and rural areas.<br>• The poorest groups can be saved for the direct negative effects of subsidy reform through social transfers and the investment of saved resources. |
| Brennan (2010) | The USA | Households surveys data | Descriptive | • Price of energy prices are too low in comparison to marginal cos. Therefore, subsidy financing through increase electricity price will ensure efficiency gains.<br>• If efficiency practice leads to reduction in electricity use, reduced revenue through energy sales can enhance substitution of efficiency for generation when efficiency cost is less. |
| Charap *et al.* (2013) | A panel of country | Cross country macro data | Regression analysis | • There is loss of consumer welfare resulting from subsidy reform.<br>• Loss of consumer welfare is larger in short term than in the long term,<br>• Gradual approach for reforming subsidy is suggested along with generous safety nets for poor households in short term. |
| Dansie *et al.* (2010) | China, India and Russia | Annual macro time series data | Descriptive | • Subsidy reform should be implemented gradually over a period of time.<br>• Major obstacles to effective subsidy reforms are the lack of public acceptance, sluggish implementation, rent seeking and lack of governments' capability to turn the savings from reforms to other welfare goods. |
| Dartanto (2012) | Indonesia | National Socio-Economic Survey data | CGE micro-simulation approach | • Energy subsidies have shrunk the fiscal space to the extent that the expenditure share of the subsidies has exceeded the share of development expenditures.<br>• Although subsidies mostly benefit |

| Study | Countries | Data Type | Methodology | Results/Conclusions |
|---|---|---|---|---|
| | | | | the middle and upper class, yet poverty is increased by 0.25 percent if one-fourth of subsidy is phased out.<br>• This adverse effect can be reduced and economic growth can be accelerated if subsidies from upper income households are transferred to poor households. |
| Freund and Wallich (1996) | Poland | Households surveys data | Regression analysis | • The first best energy pricing policy could be to increase the energy prices, while targeting the poor through a social assistance. It is socially better to use social assistant schemes and a large increase in energy price as compared to an overall, but smaller, price increase. |
| Glomm and Jung (2012) | Egypt | Annual macro time series data | Dynamic general equilibrium model | • How the cuts in energy subsidy affect economic growth depends on how government adjusts its fiscal policy. Growth effects can be realized if the freed resources are used for infrastructure investments whereas no growth effects are realized if government compensates the households by lowering other taxes.<br>• Cuts in energy subsidies without the efficient usage of energy in production can lead to even lower growth rate but the welfare effects are still realized. |
| González (2009) | Argentina | Annual data on energy subsidies from IEA (2008) | Descriptive | • High subsidies for natural gas discouraged the choice for efficiency, led to spread of unawareness on the advantages of efficiency and brought up injustices as not all the households enjoy the same benefits.<br>• Natural gas subsidy has lowered the economic efficiency because high consumption by households prevents the use of energy in production activities.<br>• It has negative consequences on environment. |
| Granado *et al.* (2012) | Developing countries | Household survey data | Descriptive | • Fuel subsidy is a costly mechanism for protecting the poor in developing countries.<br>• High income groups capture six times more benefits from energy subsidies than lower income groups. |

| Study | Countries | Data Type | Methodology | Results/Conclusions |
|---|---|---|---|---|
| Hamid And Rashid (2012) | Malaysia | Annual macro data, input-output table and Social Accounting Matrix | CGE model | • Delay in the removal of subsidies will reduce competitiveness and other related economic problems. • Gradual rationalization of energy pricing is suggested for gradual reaping of more efficient fuel utilization and efficiency. • Phasing out of the subsidies will affect the economic structure, sectors performance and welfare favorably. |
| Hosseini and Kaneko (2012) | Iran | Quarterly macro time series data | Input-output price model | • If energy subsidies are removed, rural families will suffer more inflation than the urban families. • To avoid devastating inflationary shocks, especially to poor households and to alleviate the negative effects, gradual increase in energy prices is recommended. |
| Huang and Huang (2012) | The USA | Annual macro time series data | Regression analysis | • An increase in energy prices would incur a substantial consumer welfare loss, creating an especially heavy burden for low income households. |
| Moshiri (2015) | Iran | Household surveys for 8 years | Regression analysis | • Energy demand among urban households is more sensitive to price changes, while the demand in rural areas appears more sensitive to income changes. • Since increase in energy prices is not enough to reduce energy consumption, policies have to be geared towards improving energy efficiency. |
| Nugumanova (2013) | Kazakhstan | Annual macro data | CGE model | • With energy subsidy reform energy demand will decrease; therefore there could be slight increase in the export of fuels. • For achieving goals of reform, such policies and institutions are necessary that provide incentives towards investments. |
| Silvia (2005) | Italy | Households surveys data | Regression analysis | • The welfare loss from the carbon tax has been quite substantial, but the distribution of welfare losses across different levels of income does not allow sustaining regressive Carbon taxation. • This evidence might encourage the use of Carbon taxes, at least in the transport sector, as cost-effective instruments of environmental policy. |
| Umar and Umar (2013) | Nigeria | Household | Regression | • Highest income group receives four times more benefit from fuel |

| Study | Countries | Data Type | Methodology | Results/Conclusions |
|---|---|---|---|---|
| | | Survey data | analysis | subsidy than the lowest income group. Still the welfare loss to poor households due to subsidy reform is greater due to their small income.<br>• Subsidies on fuel are costly in protecting the poor households as there is a substantial leakage of benefits to the households with higher incomes.<br>• Subsidy reform is necessary but has to be implemented gradually along with programs for mitigating the welfare loss to poor and middle income groups. |
| Vagliasindi (2012) | Developing countries | Annual macro data and household survey data | Descriptive | • Compensating vulnerable groups is an important condition for successful reforms.<br>• Subsidy reforms also depend on the credibility of the government commitment.<br>• Subsidy reforms meet success when the funds freed from reforms are used for more pro-welfare activities.<br>• Public should be informed about the benefits of subsidy reform and also about the compensating measures. |
| Widodo *et al.* (2012) | Indonesia | Social Accounting Matrix | General equilibrium model | • By reallocation of freed funds to agriculture, trade, food and beverages sectors, adverse impacts of subsidy reform can be reduced.<br>• Government should design a clear long-term scheduled and gradual program for energy subsidy reforms.<br>• All of a sudden a total removal of fuel subsidy will be a shock for the economy.<br>• Government should not consider policies such as “targeted fuel subsidy” for correcting the misallocation. |
| Zhang (2011) | Turkey | Households surveys data | Regression analysis | • Rich households are more responsive in adjusting consumption to energy price changes as compared to poor households.<br>• The welfare loss to the poorest income quintile (the change in consumer surplus as a percentage of income) is 2.9 times that of the highest income quintile. |

## III. SPECIFICATION OF HOUSEHOLD DEMAND SYSTEM

Although quite a few functional forms of household demand functions are available in the literature, we choose Almost Ideal Demand System (AIDS) of Deaton and Meulbauer (1980). AIDS is considered as a major breakthrough in demand system. Alston and Chalfant (1993) commented that, in a relatively short time since the introduction of AIDS, economists had adopted it to the extent that it appeared to be the most popular of all demand systems. This is an ideal demand system because this system satisfies almost all the axioms of choice and hence, satisfies the properties of a theoretical demand system in spite of being quite flexibility. Without invoking linear parallel Engel curves, it aggregates perfectly over consumers (Deaton and Meulbauer, 1980). Its estimation is straightforward. In particular, its linear approximated version avoids the need for non-linear estimation.

The system is based on an expenditure function of the form:

$$log\ [M(p,u)] = (1-u)\, log\ [a(p)] + u\, log\ [b(p)] \quad (1)$$

where $M$, $u$, $p$ denote total expenditure, utility and the price vector respectively and

$$log\ [a(p)] = \alpha_0 + \sum_k \alpha_k\, log(p_k) + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj}\, log(p_k)\, log(p_j) \quad (2)$$

$$log\ [b(p)] = log\ [a(p)] + \beta_0 \prod_k (p_k)^{\beta_k} \quad (3)$$

Substituting Eqs. (2) and (3) into Eq. (1), yields:

$$log\ [M(p,u)] = \alpha_0 + \sum_k \alpha_k\, log(p_k) + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj}\, log(p_k)\, log(p_j) + u\, \beta_0 \prod_k (p_k)^{\beta_k} \quad (4)$$

The uncompensated demand function for any good $i$ is obtained in two steps. By taking derivative of the above expenditure function with respect to $log(p_i)$ and applying Shepherd's lemma in the first step, the compensated demand function is obtained in the form of expenditure share equation of good '$i$'. The second step is to substitute in the resulting equation the indirect utility function, which can be obtained by inverting the above expenditure function. The result would be the demand system of good i expressed in expenditure share form:

$$s_i = \alpha_i + \sum_j \gamma_{ij} \log(p_j) + \beta_i \log\left(\frac{M}{P}\right), \qquad (5)$$

$\gamma_{ij} = \frac{1}{2}\left(\gamma^*_{ij} + \gamma^*_{ji}\right)$ and $P$ is the price index, defined as:

$$\log(P) = \alpha_0 + \sum_k \alpha_k \log(p_k) + \frac{1}{2}\sum_k \sum_j \gamma_{kj} \log(p_k)\log(p_j) \qquad (6)$$

Based on theoretical properties of demand system certain restrictions are imposed on parameters of Eqs. (5) and (6). These restrictions are:

$$\gamma_{ij} = \gamma_{ji} \qquad (7)$$

$$\sum_i \alpha_i = 1, \quad \sum_i \beta_i = 0, \quad \sum_i \gamma_{ij} = 0 \qquad (8)$$

Eq. (7) implies that the demand system satisfied Slutsky symmetry conditions, while Eq. (8) ensure that the demand system satisfies the adding up and homogeneity conditions.[3].

The demand functions given in Eq. (5) are nonlinear in parameters**.** The natural starting point for predictions using AIDS model is that in the absence of changes in the relative prices and real expenditure (*M/P*), the budget shares are constant and this is the simple interpretation if AIDS. The changes in real expenditure works through the parameter $\beta_i$ and the changes in relative prices operate through the parameters $\gamma_{ij}'s$. Further note that $\beta_i's$ add up to zero and are positive for luxuries and negative for necessities.

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[3] In the original draft of the paper we had also considered Linear Approximate AIDS (LA/AIDS) as proposed in Deaton and Meulbauer (1980), in which the price index given by Eq. (6) is approximated by Stone's (1953) price index. However, with this linear approximation version it is not possible to estimate intercept $a_0$ in Eq. (6), which is needed for the welfare analysis of energy price changes presented in section 4.

## IV. WELFARE EFFECTS OF ENERGY PRICE CHANGES

The first consideration while analyzing the effects of energy price changes on consumers' welfare is the choice of a welfare measure. Since utility is not measurable, the effects of price changes on the welfare can only be measured in monetary terms. A simple way is to compute the effects of price changes on total expenditure incurred in purchasing a given basket. The only advantage of this measure is that it allows the easiest calculation for welfare effects of price changes but it does not capture the true welfare effects as it assumes that consumers do not at all respond to price changes. The alternative approach of involving the concept of consumer surplus that allows for changes in demands in response to price changes is obviously preferable.

The typical measure of consumer surplus as presented in basic textbooks of microeconomics is based on the assumptions that utility is measurable cardinally and that the marginal utility of money is constant [See Winch (1971)]. Alternative measures of consumer surplus have been proposed that do not require these two assumptions. Winch (1971) explains four alternative measures of consumer surplus, known as compensating variation, equivalent variation, compensating surplus and equivalent surplus. Although any one of these measures can be used to estimate the effects of energy price changes on welfare of consumers, the most suitable one, as will become obvious in the following analysis is the compensating variation, which measures the increase in income that compensates for the price increase or the decrease in income as may be the case.

Let us denote the initial and the proposed prices by $P_k^0$ and $P_k^1$ respectively and the initial income by $M^0$. The first step is to compute the value of utility using the Indirect Utility Function (IUF), which can be obtained by inverting the expenditure function given by Eq. (4) for utility. The result is:

$$U^0 = \frac{\log\left(M^0\right) - a_0 - \sum_k a_k \log\left(p_k^0\right) - \frac{1}{2}\sum_k \sum_j \gamma_{kj}^* \log\left(p_k^0\right)\log\left(p_j^0\right)}{\beta_0 \prod_k \left(p_k^0\right)^{\beta_k}} \qquad (9)$$

The value of utility obtained above is used to compute the value of the log of expenditure at the new prices using the expenditure function (Eq. 4) as follows.

$$log\left(M^1\right)=a_0+\sum_k a_k\, log\left(p_k^1\right)+\frac{1}{2}\sum_k\sum_j \gamma_{kj}^{*}\, log\left(p_k^1\right)log\left(p_j^1\right)+U^0\ \ \beta_0\ \ \Pi_k\left(p_k^1\right)^{\beta_k} \quad (10)$$

Substituting for $U^0$ from Eq. (9), we obtain:

$$\begin{aligned} log\left(M^1\right)=&\ a_0+\sum_k a_k\, log\left(p_k^1\right)+\frac{1}{2}\sum_k\sum_j \gamma_{kj}^{*}\, log\left(p_k^1\right)log\left(p_j^1\right) \\ &+\left[log\left(M^0\right)-a_0-\sum_k a_k\, log\left(p_k^0\right)-\frac{1}{2}\sum_k\sum_j \gamma_{kj}^{*}\, log\left(p_k^0\right)log\left(p_j^0\right)\right]\Pi_k\left(\frac{p_k^1}{p_k^0}\right)^{\beta_k} \end{aligned} \quad (11)$$

Note that in the estimation of AIDS, we estimate only the share equations but we cannot estimate the expenditure function or the IUF. This means that all parameters of the system except $\beta^0$ are estimated. However, as we can see from Eq. (11), this parameter drops out in the computation of the expenditure at new prices but old level of utility. This means that despite not being able to estimate $\beta^0$, we are able to make all the necessary computations for our welfare analysis.[4]

Finally, given the initial total expenditure $M^0$ and the computed new expenditure to retain the initial level of utility, $M^1$, we obtained the percentage compensating variation while moving from old prices to new prices as follows.

$$CV=\frac{M^1-M^0}{M^0}100 \quad (12)$$

The welfare effects of changes in energy prices can be analyzed by employing the actual and hypothetically specified energy prices. One approach for setting the hypothetical energy prices, which is quite often adopted in the literature, is to consider the existing energy subsidies and then see what impact the removal of these subsidies will have on

[4] The welfare analysis proposed above is not possible in case of LA/AIDS, because the parameter $a_0$ cannot be estimated in this system.

consumers (see the section on literature review). This approach is appropriate when analyzing the effect of removing one specific structure of energy subsidies. But, by using this approach it becomes quite difficult to analyze the cumulative effect of removing all distortions that exist due to the introduction of taxes and subsidies applied in the past. In case of Pakistan, for example, prices of electricity, petroleum products and natural gas are set by their respective regulatory authorities and certain amounts of subsidy and tax are implicit in price setting, especially in the presence of power tariff slabs with progressive rates and differential peak and off-peak hour rates. This practice is accompanied with specific surcharges. Quite often, under the pressure of aid-donor agencies government announces price increases but at the same time compensates consumers by removing surcharges or increasing subsidies. If one tries to read government documents, one finds that the distinction between changes in price, taxes and subsidies is blurred.

Under the above circumstances, not only it is difficult to pinpoint and analyze the impact of certain taxes or subsidies, such an analysis is also undesirable because the objective of the welfare analysis of government policies is to see how various target groups are affected on net basis. Thus, an alternative easier approach that we followed here is to set the energy prices at some benchmark level and then compare the effect of difference between the actual and the benchmark levels.

One may also account for the possible indirect effects of energy price changes through the resulting changes in non-energy prices. When energy prices increase due to changes in pricing policy, subsidies or taxes; normally all categories of the users of energy besides households are affected. Since energy is also used as an input, the increase in energy prices can cause increase in other goods' prices as well.

It follows that estimating the effects of energy price changes on consumers in a precise manner is not a straightforward task. A practical way is to simulate the welfare effects of energy price changes by creating a number of scenarios. Thus, we consider the following cases for the welfare analysis.

Case 1, Direct Energy Price Effect:

Compensating variation in response to x% increase in prices of all energy items, holding all other prices constant

Case 2, Energy and Non-energy Price Effects:

Compensating variation in response to x% increase in prices of all energy items, allowing for the spillover effect of energy price increase on non-energy prices

The value of the percentage factor x is set to vary between 1% and 100% in order to capture the possible non-linearity in the relationship between prices and compensating variation.

The calculation of compensating variation in case 1 is straightforward and can be carried out by using Eqs. (11) and (12), wherein the prices of energy goods are raised by x% and all other prices are held constant. For case 2, we also need the information on the indirect (spillover) effect of energy price changes on the prices of non-energy consumption goods. This indirect effect of energy price hike on the non-energy prices is estimated using an auxiliary time-series regression model. Since non-energy inflation may also be caused by usual factors like money growth, exchange rate depreciation and lack of output growth, the model includes non-energy price index as the dependent variable and energy price index, quantity of broad money (M2), nominal exchange rate (Pak rupees per US dollar) and real GDP as independent variable. Denoting non-energy price, energy price, quantity of money, exchange rate and GDP by $P_{NE}$, $P_E$, *M2*, *ER* and *Y*, respectively in natural logs, the model is specified as:

$$log(P_{NE}) = b_0 + b_1 log(P_E) + b_2 log(M2) + b_3 log(ER) + b_4 log(Y) + U \quad (13)$$

Since the parameter $b_1$ measures the effect of one percentage increase in energy price on non-energy price, the indirect effect of x% increase in the prices of energy goods on the prices of non-energy goods is given by $b_1 x\%$. It follows that the compensating variation in case 2 can be estimated by raising the prices of energy goods by x% and the prices of non-energy goods by $b_1 x\%$ in Eq. (11).

Further, to draw distributional implications of energy pricing policies, the effects of price changes are also estimated at the mean per capita total expenditure of each of the five household groups separated by the four quintiles of total expenditure, considering both the cases outlined above.

## V. DATA AND VARIABLES

While estimating household demand function in Pakistan limited data availability poses a major problem. Although rich cross-section data are available in the form of *Household Integrated Economic Survey (HIES)*, previously known as *Household Income and Expenditure Survey (HIES*) and *Pakistan Social and Living Standards Measurement (PSLM*) that provide a lot of useful information, these data are not helpful for analyzing the effects of price changes on consumers' choices. Even the limited information on prices of a few goods that can be obtained from the expenditures and quantities consumed reported by households reflects differences in quality chosen by and the market information available to consumers rather than any genuine price variation. The alternative to cross-sectional data is the time-series aggregate data that do provide information on prices but only indirect information on quantities consumed. Household consumption is usually derived indirectly by adding imports and subtracting exports from the annual production and using some ad hoc assumption about changes in stocks. These dubious data along with limited sample size also make the alternative of time-series data unattractive.

Therefore, to overcome the problems associated with pure cross-section or pure time-series data, we pool a number of cross-section data sets. This allows making use of the income variation in cross-sectional as well as time dimensions and at the same time benefiting from the price variation in the time dimension. All the information except on prices is obtained from the survey data, while the information on prices is obtained from time-series data assuming that all consumers face the same set of prices. Another advantage of pooling is the availability of reasonably large sample to yields sufficient degrees of freedom. It is expected that with the pooled cross-section and time-series data parameter estimates of the demand system will be more reliable than the estimates obtained from pure cross-section or pure time-series data.

This study uses the data of *HIES* for rural and urban areas of Pakistan for the fourteen survey over the period 1985 to 2013, conducted by Pakistan Bureau of Statistics (PBS). This data set divides households into several income groups and provides information about the expenditures made by households on various commodities like wheat, sugar, electricity, travel, etc. and the commodity groups like fuel & lighting, food & beverages, house rent & housing and communications, etc. Since the present study focuses on energy demand, we consider energy items in disaggregated form and the rest of the goods and services at aggregated forms. The total household expenditure is classified into four categories of energy consumption and five categories of other (non-energy) consumption, which are electricity, gas, kerosene oil, firewood & coal, food & beverages, apparel, textile & footwear, house rent & housing, transport & communications, and miscellaneous. The goods included in the miscellaneous category are furniture & household equipment, education and recreation.

Data on prices or price indices of the nine goods used by this study are obtained from various issues of *Pakistan Economic Survey* published by Ministry of Finance (MOF) and *Pakistan Energy Yearbook* published by Ministry of Petroleum and Natural Resources, Government of Pakistan. All price indices are converted to the base year 2001-02. The CPI of the category Miscellaneous is derived by using the aggregation identity whereby the overall CPI is the weighted sum of the CPIs of the sub-categories, where weights are the consumption shares in the base year. The weights are computed on the basis of household consumption data are taken from *HIES*.

For the estimation of the auxiliary Eq. (13), quarterly data are used for the period: third quarter 1988 to second quarter 2014. Data on all the variables used in Eq. (13) except GDP are taken from *Pakistan Economic Survey* and *Pakistan Energy Yearbook*, while the data on quarterly GDP are taken from Kemal and Arby (2004) and Hanif, *et al*. (2013).

## VI. ESTIMATION AND RESULTS

In econometrics context AIDS is a non-linear Seeming Unrelated Regressions (SUR) model and is to be estimated by iterative GLS method of Zellner (see Greene, 2003). The system is estimated separately for the rural and urban areas of Pakistan. The parameter estimates of AIDS are shown in Tables 2 and 3 for the rural and urban areas of Pakistan respectively

TABLE 2

Parameter Estimates of AIDS for Rural Pakistan

| | Electricity | Gas | Kerosene | Firewood | Food | Apparel | Housing | Transport | Misc. |
|---|---|---|---|---|---|---|---|---|---|
| Alphas | -0.3256 | -0.346 | 1.1345$^{*}$ | 2.7586$^{*}$ | 18.459$^{*}$ | 2.4995$^{*}$ | 1.205$^{\#}$ | -5.1736$^{*}$ | -19.212$^{*}$ |
| Betas | 0.0012$^{\#}$ | 0.0013$^{+}$ | -0.0043$^{*}$ | -0.0103$^{*}$ | -0.0681$^{*}$ | -0.0093$^{*}$ | -0.0040$^{*}$ | 0.0199$^{*}$ | 0.0736$^{*}$ |
| Gemmas | | | | | | | | | |
| Electricity | 0.0265$^{*}$ | 0.0163$^{*}$ | -0.0002 | -0.0094$^{+}$ | 0.0318$^{\#}$ | 0.0170$^{*}$ | -0.0420$^{*}$ | -0.0210$^{*}$ | -0.0190 |
| Gas | 0.0163$^{*}$ | -0.0074 | 0.0013 | 0.0280$^{*}$ | 0.0006 | -0.0181$^{\#}$ | -0.014$^{\#}$ | 0.0077 | -0.0144 |
| Kerosene | -0.0002 | 0.0013 | -0.0108$^{*}$ | -0.0146$^{*}$ | -0.0789$^{*}$ | -0.0113$^{*}$ | 0.0098$^{+}$ | 0.0340$^{*}$ | 0.0707$^{*}$ |
| Firewood | -0.0094$^{+}$ | 0.0280$^{*}$ | -0.0146$^{*}$ | -0.0032 | -0.2086$^{*}$ | -0.0025 | -0.0131 | 0.0286$^{\#}$ | 0.1948$^{*}$ |
| Food | 0.0318$^{\#}$ | 0.0006 | -0.0789$^{*}$ | -0.2086$^{*}$ | -1.0673$^{*}$ | -0.2270$^{*}$ | -0.0144 | 0.3548$^{*}$ | 1.2092$^{*}$ |
| Apparel | 0.0170$^{*}$ | -0.0181$^{\#}$ | -0.0113$^{*}$ | -0.0025 | -0.227$^{*}$ | 0.1773$^{*}$ | -0.0178 | -0.0439$^{\#}$ | 0.1264$^{*}$ |
| Housing | -0.0420$^{*}$ | -0.0140$^{\#}$ | 0.0098$^{+}$ | -0.0131 | -0.0144 | -0.0178 | -0.0525$^{*}$ | 0.0655$^{*}$ | 0.0786$^{+}$ |
| Transport | -0.0210$^{*}$ | 0.0077 | 0.0340$^{*}$ | 0.0286$^{+}$ | 0.3548$^{*}$ | -0.0439$^{\#}$ | 0.0655$^{*}$ | -0.0772$^{*}$ | -0.3485$^{*}$ |
| Misc. | -0.0190 | -0.0144 | 0.0707$^{*}$ | 0.1948$^{*}$ | 1.2092$^{*}$ | 0.1264$^{*}$ | 0.0786$^{+}$ | -0.3485$^{*}$ | -1.2977 |
| R-Square | 0.9470 | 0.5204 | 0.6582 | 0.5271 | 0.6191 | 0.7577 | 0.2693 | 0.6753 | 0.7157 |

The parameters significant at 1%, 5% and 10% levels are indicated by the signs *, # and + respectively.

In case of rural areas of Pakistan the intercepts $\alpha_i's$ for kerosene oil, firewood & coal, food & beverages, apparel textile & footwear, and house rent & housing are positive and highly significant with reasonable magnitudes, which indicate that significant portions of expenditures on these commodities are independent of the changes in prices and incomes. The intercept term for natural gas, transport & communications and miscellaneous category of goods are negative and significant, which indicates that the shares of these goods will be negative if price and income effects are ignored. Only in case of electricity and gas the intercept is statistically insignificant. In case of urban areas of Pakistan the intercept terms are positive for electricity, kerosene oil, firewood & coal, food & beverages and apparel textile & footwear and negative for natural gas, house rent & housing, transport & communications and miscellaneous category but these are all statistically insignificant. Thus, while in rural areas expenditure shares are mostly dependent on income and/or prices, in urban areas the shares remain mostly independent.

TABLE 3

Parameter Estimates of AIDS for Urban Pakistan

| | Electricity | Gas | Kerosene | Firewood | Food | Apparel | Housing | Transport | Misc. |
|---|---|---|---|---|---|---|---|---|---|
| Alphas | 0.0176 | -0.0236 | 0.0342 | 0.1751 | 1.4762 | 0.1676 | -0.1724 | -0.2573 | -0.4173 |
| Betas | -0.0002 | 0.0034* | -0.0037* | -0.0136* | -0.0862* | -0.0067* | 0.0310* | 0.0250* | 0.0509* |
| Gemmas | | | | | | | | | |
| Electricity | 0.0309* | 0.0110* | 0.0002 | -0.0041 | 0.0051 | -0.0059 | -0.0346* | -0.0091+ | 0.0065# |
| Gas | 0.0110* | -0.0023 | 0.0047* | -0.0013 | 0.0043 | -0.0117+ | -0.0077 | -0.0037 | 0.0068 |
| Kerosene | 0.0002 | 0.0047* | -0.0071* | -0.0018 | -0.0037 | 0.0023 | -0.0003 | 0.0052 | 0.0004 |
| Firewood | -0.0041 | -0.0013 | -0.0018 | 0.0239+ | -0.0457 | -0.0116 | 0.0002 | 0.0309 | 0.0094 |
| Food | 0.0051 | 0.0043 | -0.0037 | -0.0457 | -0.0606 | 0.0239 | 0.1087 | -0.0362 | 0.0043 |
| Apparel | -0.0059 | -0.0117+ | 0.0023 | -0.0116 | 0.0239 | 0.0260 | -0.0479* | 0.0119 | 0.0130 |
| Housing | -0.0346* | -0.0077 | -0.0003 | 0.0002 | 0.1087 | -0.0479* | -0.0556 | 0.0407 | -0.0035 |
| Transport | -0.0091+ | -0.0037 | 0.0052 | 0.0309 | -0.0362 | 0.0119 | 0.0407 | -0.0079 | -0.0317 |
| Misc. | 0.0065# | 0.0068 | 0.0004 | 0.0094 | 0.0043 | 0.0130 | -0.0035 | -0.0317 | -0.0052 |
| R-Square | 0.9401 | 0.8103 | 0.7957 | 0.6807 | 0.7448 | 0.7046 | 0.4381 | 0.7512 | 0.5981 |

The parameters significant at 1%, 5% and 10% levels are indicated by the signs *, # and + respectively

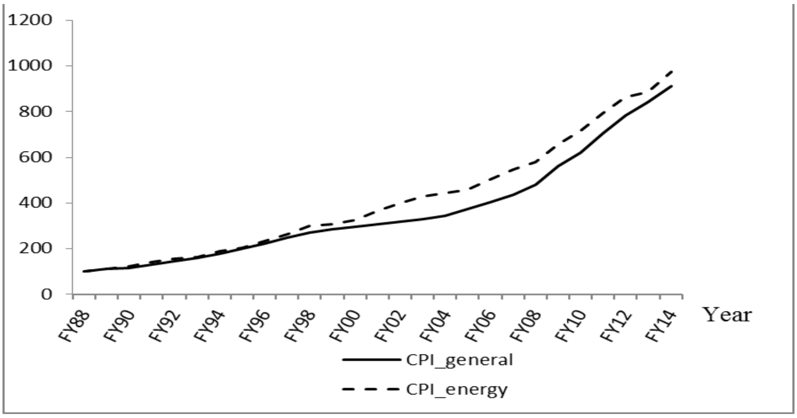
The sign of $\beta_i$ determines whether a good is a relative luxury or necessity. If $\beta_i > 0$ ($\beta_i < 0$), the good *i* is classified as luxury (necessity) meaning that in response to increase in real total expenditure by a given proportion, the demand for the good i will increase by a greater (smaller) proportion. The results in case of rural areas of Pakistan show that $\beta_i's$ for kerosene oil, firewood & coal, food & beverages, apparel, textile & footwear and house rent & housing are negative and statistically significant indicating that these goods are necessities. The parameters $\beta_i's$ for electricity, natural gas, transport & communications and miscellaneous goods are positive and statistically significant, indicating that these goods are luxuries Pakistan. In urban areas of Pakistan, electricity, kerosene oil, firewood & coal, food & beverages and apparel, textile & footwear are classified as necessities as indicated by the negative sign of the corresponding $\beta_i's$ while natural gas, house rent & housing, transport & communications and miscellaneous goods are luxuries. The changes in the shares of various goods due to changes in relative prices are indicated by the signs and magnitudes of $\gamma_{ij}'s$. We can see that the expenditure shares of both the energy and non-energy items in rural sample are by far more sensitive to price changes than those in the urban sample.

Coming to the estimation of the auxiliary Eq. (13), it is to be noted that spurious regression is the major concern in the time series regression. Therefore, estimate of the equation is extracted from the full ARDL model. Since this equation is not the focus of analysis, only an auxiliary exercise, only the results of short-run and long-run effects of energy price index on the non-energy price index are presented. According to the estimates the long-run effect of one percentage point increase in energy price index on the non-energy price index (the value of the parameter $b_1$ in Eq. 15) is 0.22, while the corresponding short-run effect is only 0.029, which is one-eighth of the long run effect. Therefore to take into account the inflationary spillover of energy price increases on prices of other goods, for every one percentage point increase in energy prices, the prices of other goods are increased by 0.22 percentage points. Since the short-run spillover is negligible, no short run analysis is carried out.

Figure 1 shows the trend in overall CPI and CPI of fuel and lighting (referred to as CPI_general and CPI_energy respectively) in Pakistan over the study period. The figure shows that both the price indices have increased exponentially but the rate of increase in general CPI has been greater than the one in CPI of fuel and lighting. The annual compound inflation rates in general and fuels and lighting price indices has indices have been 8.99% and 9.15% respectively. Since both the price indices have grown quite rapidly, it is important to consider the indirect welfare effects of energy price variation through its spillover effect on the prices of non-energy goods. Both the direct and total (direct plus indirect) effects of energy price variations are discussed below.

FIGURE 1

Trends of General and Energy Consumer Prices Indexes




For the welfare analysis, we first consider the estimated percentage compensating variation (Eq. 12) for the representative rural and urban households associated with the increases in energy prices with and without considering the spillover of energy price increases on other goods' prices. Table 4 presents the results for price increases from 10% to 100% with intervals of 10 percentage points. The table shows that there is not much difference in the compensating variation between the rural and urban samples. In both the cases the rate of compensating variation increases almost proportionately with the increase in energy prices. The correlation coefficient between the rate of energy price inflation and the rate of compensating variation is more than 0.99 for each of the four cases presented in the table. This linearity implies that there is no additional substantial long-run welfare gain or loss if the targeted increase in energy prices is staggered over some period.

TABLE 4

Size of Compensating Variation against Energy Price Increases

| | Rural sample | | Urban sample | |
|---|---|---|---|---|
| Percentage increase in energy prices | Compensating variation (direct effect) | Compensating variation (direct plus spillover effects) | Compensating variation (direct effect) | Compensating variation (direct plus spillover effects) |
| 10 | 0.73 | 2.77 | 0.76 | 2.79 |
| 20 | 1.48 | 5.55 | 1.51 | 5.58 |
| 30 | 2.25 | 8.34 | 2.26 | 8.37 |
| 40 | 3.02 | 11.14 | 2.99 | 11.15 |
| 50 | 3.80 | 13.94 | 3.70 | 13.92 |
| 60 | 4.58 | 16.74 | 4.41 | 16.69 |
| 70 | 5.35 | 19.54 | 5.10 | 19.45 |
| 80 | 6.12 | 22.35 | 5.78 | 22.21 |
| 90 | 6.89 | 25.15 | 6.45 | 24.96 |
| 100 | 7.65 | 27.96 | 7.11 | 27.71 |

The results further show that if the spillover effects of energy price increases on the prices of non-energy goods are also taken into account, the size of compensating variation will increase to almost four times. Whether or not one should take into account the spillover effects in considering compensation of consumers is a tricky question. One may argue in favor of taking into account the spillover effects on the grounds that the increase in price of any good will result in welfare loss irrespective of whether this price increase constitutes part of the pricing policy or is a secondary consequence/spillover of the original policy. On the other hand, a counter argument is that if the spillover effects on the prices of non-energy goods are taken into account in any compensation package, there will be an equally valid argument to reduce the size of compensating variation to the extent that households' incomes changes as wages of household members tend to catch up with price inflation. However, it is not feasible to consider this aspect in the present framework because the welfare analysis here is based on compensating variation itself, that is, the change in total expenditure (as a proxy of income) required to compensate for the price variation. Since one cannot altogether ignore the changes in income brought about by energy price increases, the size of compensating variation estimated here indicates a benchmark against which the realized income changes can be compared.

This interpretation can be useful in designing the overall energy pricing policy including the possible compensation package.

Whether and how the consumers should be compensated for the welfare loss is a normative question and the answer depends on the ultimate objective of the proposed energy pricing policy. If the objective is to raise government revenues then the compensation should be focused on the distributional aspects of the policy with no intention to make the full or even a partial compensation to all consumers. If, on the other hand, the proposed pricing policy aims at removing price distortions with no consideration of revenue generation then the compensation scheme would include both real income as well as distributional considerations.

In a developing country like Pakistan, energy pricing policy is often influenced by external pressure from the aid-donor agencies in a bid to raise government revenue in order to reduce the country's dependence on borrowing and to increase its capacity to timely meet its debt servicing obligations. Under this situation across the board compensation of consumers seems counter-productive and the role of compensation is to be confined to distributional consideration only. In order to explore the distributional implications of energy pricing policies, we now present the estimated size of compensating variation at the mean per capita total expenditure of the lowest and the highest quintiles of total expenditure.[5]

Figures 2 to 5 show the size of compensating variation associated with varying percentage increases in energy prices for the lowest and highest quintiles of total expenditure (representing relatively poor and rich households). The figures indicate that the percentage compensating variation is higher for the lowest quintile of total expenditure as compared to the one for the highest quintile both in the rural and urban samples. The difference is, however, negligible if the spillover effects of energy price increases on non-energy prices are taken into account. To understand why the difference becomes smaller when the spillover effects are taken into account, note that in the first place the difference arises due to different preference structures between the poor and rich households. When prices of energy items increase, the consumers are

[5] Since the size of compensating variation does not show much difference across the expenditure quintiles, we present the results for the extreme quintiles only.

able to avoid the welfare loss to the extent they can substitute from energy to non-energy consumption goods. The size of welfare loss will obviously depend on the differences in preferences between the poor and rich households. On the other hand, when spillover effects of energy price increases on non-energy prices are also taken into account, the consumers' ability to avoid the welfare loss through substitution is curtailed because the changes in relative prices between energy and non-energy goods are now relatively less and, hence, differences in preferences between the poor and rich households also matter less.

FIGURE 2

CV for Energy Price Increase (Rural Sample)

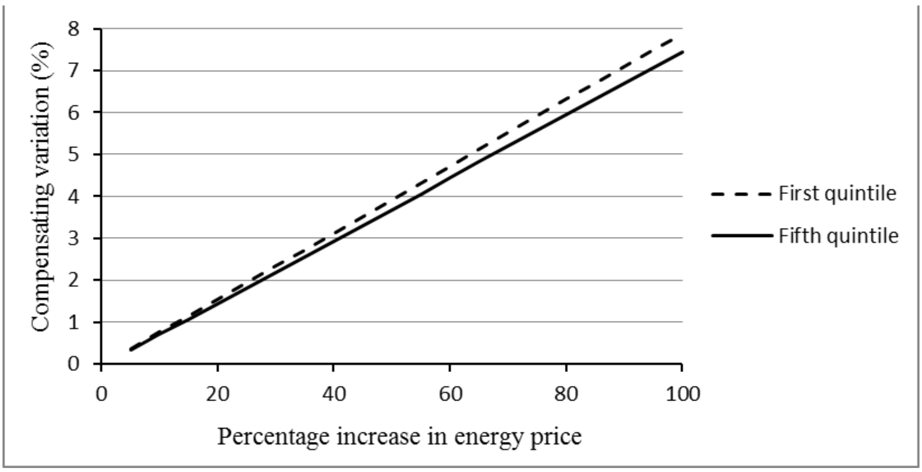
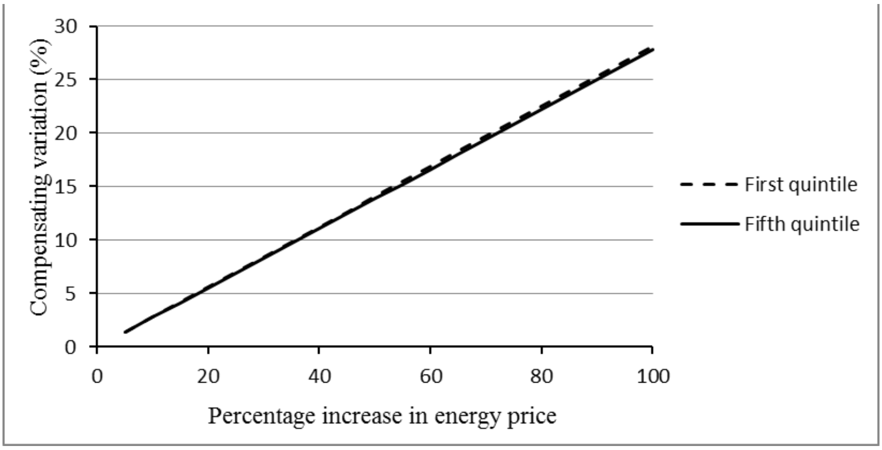


FIGURE 3

CV for Energy and Non-Energy Price Increase (Rural Sample)




We can also see that the difference in compensating variation between the poor and rich households is greater in the urban sample as compared to the one in the rural sample. This reflects that the preference structure between rich and poor households is greater in urban areas as compared to the one in rural areas.

FIGURE 4

CV for Energy Price Increase (Urban Sample)

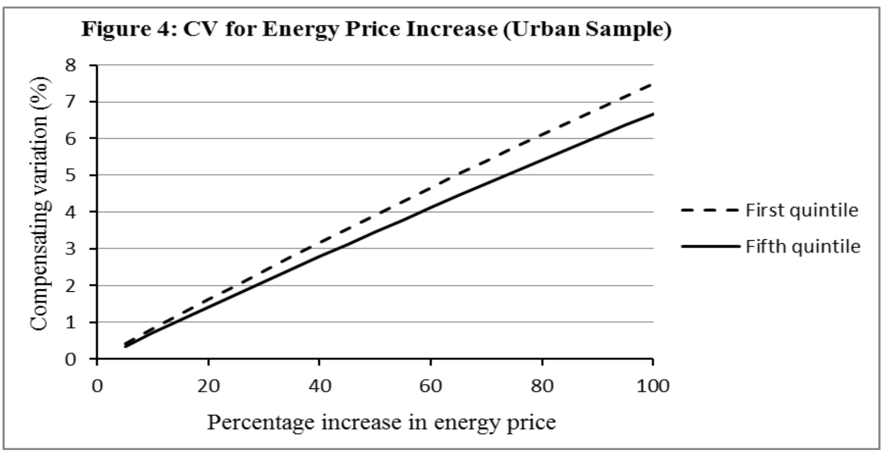
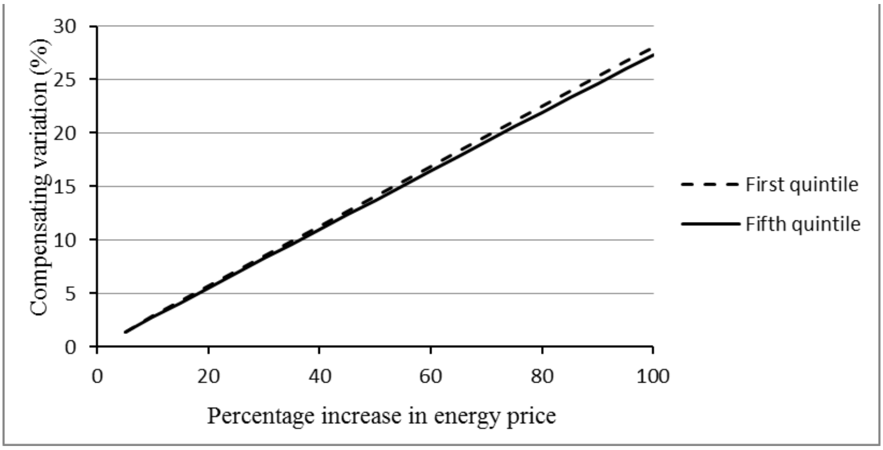


FIGURE 5

CV for Energy and Non-Energy Price Increase (Urban Sample)




In any case, the main finding here is that the size of compensating variation in percentage terms is somewhat higher among the poor households than among the rich households in all the cases considered. This means that energy price increases result is greater welfare loss to the poor households.

## VII. CONCLUDING REMARKS

This study has been an attempt to analyze the welfare effects of energy price increases on the rural and urban households of Pakistan using the Almost Ideal demand system (AIDS) estimated on the basis of Household Integrated Economic Survey (HIES) data pooled over the period 1985-86 to 2013-14. The welfare analysis is carried out by estimating percentage compensating variation in total expenditure corresponding to alternative scenarios on energy prices.

The prices of electricity, petroleum products and natural gas in Pakistan are set and regulated by their respective regulatory authorities and certain amounts of subsidy and tax are implicit in price setting in addition to the explicit subsidies, taxes and surcharges. Price changes are often accompanied by changes in taxes, surcharges or subsidies. Since it is neither feasible nor much useful to disentangle the incidences of changes in price regulations, taxes, surcharges and subsidies; welfare analysis in this paper is conducted on the basis of alternative scenarios regarding energy prices. The welfare costs (percentage compensating variations) of 1 to 100 percent increases in energy prices are estimated at the mean per capital total expenditure in the latest year of data first by ignoring and then by incorporating the possible spillover effect of energy price changes on the prices of non-energy goods and services.

The results show that welfare losses due to energy price increases are almost the same, 7.65% against 100% increase in energy prices in rural sample and 7.11% in the urban sample. Further, the rate of compensating variation is almost proportional to the increase in energy prices. If the spillover effects of energy price increases on the prices of non-energy goods are also considered, the welfare loss would be multiplied by four.

Since in Pakistan energy pricing policy is often driven by the need to improve government budget position, the role of compensation is to be confined to distributional consideration only. To gain more insight into the distributional implications of energy pricing policies, the welfare costs of energy price changes are also estimated at the mean per capita total expenditures of the household belonging to the poorest and the richest quintiles of total expenditure. The percentage compensating variation for the poorest quintile is found to be slightly greater than the one for the richest quintile in rural as well as urban areas.

The main conclusion of the study is that energy price inflation has resulted in a substantial welfare loss both for rural and urban households of Pakistan and the energy pricing policy in Pakistan has been regressive in nature in the sense that the welfare loss in percentage terms has been somewhat higher among the poor households than among the rich households.

The only comparable study for Pakistan is by Abrar (2015) that estimates welfare effects of energy price changes on the representative household. The present study extends the same work and shows that welfare loss becomes greater when the spillover effect of energy price increase on the prices of non-energy goods are also taken into consideration. The present study also shows that the welfare loss is greater for the lowest income quintile than the higher highest income quintile. It is not worthwhile to compare our results with the other study on welfare effects of energy price changes by Aziz et al. (2016) because it suffers from serious shortcoming of data and model specification as mentioned in introduction.

The policy implication of this conclusion is straightforward. There are three reasons why poor households need to be given preferential treatment while protecting them against the energy price hike. First, irrespective of the relative size of compensating variation, as compared to rich household, the poor households are in a greater need to be protected against energy price hike because their low incomes make them more vulnerable when energy prices increase. Second, the regressive effect of energy price hike means that the poor households suffer relatively greater welfare loss when energy prices increase, which makes the case of protecting poor households even stronger. Third, since the absolute expenditure on energy items among the poor households is quite small, any compensating package directed towards the poor will have affordable effect on government budget. These three reasons justify the need for a comprehensive compensation package exclusively for poor households to enable them face the burden of energy price inflation.

It is also important to consider the budgetary implications of the energy pricing policy recommended above. For example, if all the 20% poorest households are protected against 25% increase in energy prices, its impact comes out to be about 2% of the total expenditure of the poorest quintile of households, whose total expenditure is about 12.8% of the aggregate household expenditure in Pakistan. This means that the cost of subsidy would be 0.256% (that is, 2% of 12.8%) of aggregate consumption expenditure. If the average propensity to consume is set equal to 80%, the impact of subsidy would turn out to be approximately 0.2% of GDP. This amount is obviously not negligible. Currently there are various types of levies and implicit taxes on electricity, natural gas and petroleum products. A simple way out to finance the subsidy would be to exempt the poor households from certain categories of such levies and taxes.

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