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Article

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Effects of Targeting Energy Subsidies on Domestic Electricity Demand in Iran

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ABSTRACT

The ever-increasing electricity consumption in Iran, mainly due to its low and, in fact, unrealistic price, has caused the nationwide power supply network to fail meeting the demand; therefore, optimizing its price is an important issue in the management of the electricity supply and demand. Domestic energy consumption is very high in the country making it a necessity to optimize it and study the consumer's behavioral reaction towards the variations of the electricity price. Effort has been made in this paper to study the impact of the targeting of energy subsidies on domestic demand during 1991-2012 using the almost ideal demand system and seemingly unrelated regression estimation methods. Results have shown that electricity is an essential commodity for both urban and rural families; the absolute value of the price elasticity has been found to be less than unity for both. Results have also indicated that the consumption reaction against the price increase is not much. It is concluded, therefore, that mere energy pricing policies do not possibly suffice to reduce consumption; taking advantage of other supplementary policies, such as encouraging people to use low-consumption efficient electric appliances, enhancing the public level of awareness and culture of correct consumption, and so on, is also necessary. This paper has been so organized as to introduce the subject in section one, review the related previous studies in section two, present the quantitative model used for the study in section three, present the data and methodology in section four, discuss the results in section five, and provide conclusions and policy implications in section.

Keywords: Almost Ideal Demand System, Seemingly Unrelated Regression, Targeting Energy Subsidies, Domestic, Electricity, Demand
JEL Classifications: C1, C3, C5, D1, D4, R2, Q4

1. INTRODUCTION

After the industrial revolution, various energy carriers, and specifically within the few past decades, the electrical energy, have played an important role in the development of the human societies and, over time, their importance in the social and economic lives of such societies has become quite evident. The increase in the production cost, huge investments needed to construct power plants, production-related environmental pollution, and the unwise and reckless consumption patterns due to low prices and unrealistic pricing policies, have created an urgent need for the implementation of more effective pricing policies and efficient management systems of supply and demand. Direct and indirect government subsidies to energy carriers have created a variety of problems in their production, distribution and especially consumption and have made social welfare a far-reaching goal. Since the high-income class consume more (compared to the low-income), the energy subsidies are generally in their favor (Yazdani, 2011). In this regard, studying the consumers' demand structure and evaluating their reaction to price variations are necessary to plan to better control and direct the demand.

As a government pressing issue, the "law of targeting subsidies" was approved by the "Islamic consultative assembly" on October 2010 and implemented on December 2011; this could be an important step in increasing productivity, improving the resource allocation policies and reducing high costs of energy subsidies (Majlese Showraye Eslami Iran). It should be noted, when studying the energy consumption in Iran, that the domestic consumption (lights, household appliances, and air conditioning) is one of the main sources of the electric power demand. In 2012, per capita domestic consumption equaled 2614.3 KWH (2.3% more than that in 2011) because the second phase of the subsidies law was not implemented and the people's electricity consumption behavior

returned to the previously established pattern. In that year, the domestic consumption accounted for 31.6% of the total electricity demand, the second highest in the country after the industrial sector while in 2011, despite a 5.5% increase in the number of domestic consumers, it totaled 56773.7 GW indicating a 6.8% decline compared to that of the year before. This reduction was largely due to the implementation of the Law of Targeting Subsidies and to the better demand management. It is worth mentioning that per capita domestic consumption in 2011 reached 2555.5 KWH indicating 11.7% decline compared to that in 2010 (Energy Balance Sheet, Ministry of Energy, 2012).

Price is another important parameter influencing the electricity demand and consumption; in the late 2010, with the implementation of the law of targeting subsidies, the prices of various energy carriers increased substantially (26.5% for electricity) and in 2011 the nominal price of electricity, compared to the year before, was almost doubled. It can be observed that if the share of the price increase due to general inflation is eliminated, the real electricity price has had an increase of 61.4% in 2011 compared to that in 2010. The average electricity price has reached from 409.5 rials per WH in 2011 to 407 in 2012 showing a 0.6% decrease; in the domestic and agricultural sectors, this average has had an increase while in the public and industrial sectors it has had a decrease. The highest KWH price increase has been in the miscellaneous consumers sector (64.3 rials) and the highest decrease has been in the industrial sector (14.4 rials) (Energy Balance Sheet, Ministry of Energy, 2012).

2. LITERATURE REVIEW

So far, there have been numerous research studies (both national and international) as follows on the electricity demand resulting in different price and income elasticity values.

Nationally, Lotfalipour and Lotfi (2004) have studied the factors affecting the domestic electricity demand in Khorasan province, Iran, and have concluded that, for domestic applications, electricity and other energy sources are not replaceable. In another study, Bakhtiyari (2004) has concluded that targeting subsidies is to begin with gasoline first, because its distribution, compared to other energy carriers, is unfair, and then to continue with the electricity. Moshiri and Shahmoradi (2006) have suggested that electricity is an inelastic and necessary commodity while Sadeghi et al. (2012) have concluded that in rural areas and for low-income families electricity is a luxury that can be replaced by kerosene and natural gas.

Internationally, Fisher and Kaysen (1962) have studied the electricity demand in the domestic and industry sectors in the United States and have concluded that the number of electric household appliances depends much on the income, population, and number of families not on the price of electricity. Matsukawa et al. (1993) have asserted that, in Japan, electricity is inelastic in the domestic sector. Uri and Boyd (1997) have evaluated the economic effects of the electricity price increase (in addition to other energy carriers) in Mexico and have concluded that the increase would reduce the consumption level. Fetini and Bacan (1999) have studied the impacts of adjusting (to the international level) the electricity price on other commodities and on the standard of living in Iran, and have concluded that only 8 (out of 43) economic sectors have experienced price increases higher than 20%. Jensen et al. (2002) have studied the energy, business, and foreign currency increase policies in Iran and have concluded that targeting subsidies, in addition to other appropriate systems, can reduce the negative impacts of price adjustments on the low-income groups. The World Bank (Social and Economic Development Group, Middle East and North Africa Region) (2003) has studied the situation of the energy carriers and their price increase in Iran and has concluded that if the prices were increased up to the international levels, the general inflation rate would increase by 30.5%. Van Heerden (2005) has studied the inflationary effects of the electricity price increase in South American countries and has observed that such policies have resulted in fixing wages. Gundimeda and Kohlin (2008) have used the LA-almost ideal demand system (AIDS) method to estimate the elasticity for electricity and other energy carriers and have concluded that to predict the future domestic electricity demand, it is necessary that the income distribution be also considered in addition to the population size and income level. Ngui et al. (2011) have studied the electricity demand (together with other energy carriers) in Kenya and have concluded that it has no price elasticity. Fan and Hyndman (2011) have studied the price elasticity of electricity demand in South Australia, Lee et al. (2014) have studied electricity demand in the low energy house sector in Australia, and Bernestein and Madlener (2015) have studied short and long term electricity demand elasticity in Germany.

In all the above studies, focus has been on the total (urban and rural) domestic electricity demand (with no distinction between the two); therefore, any generalization of the results to either of the two would be questionable. Besides making the above mentioned necessary distinction between the urban and rural demands in Iran, the present study uses the AIDS estimation method to analyze the electricity share in the total family budget (in comparison with other goods and commodities used by the households) to formulate the demand equations at the national level.

3. MODELING

A demand function shows different levels of any commodity that the consumer is willing or is able to buy provided that other factors remain unchanged. The quantity purchased depends on several factors the important ones of which are as follows:

- Price of the commodity, Pi.
- Prices of other commodities, $P_1 \ldots P_n$.
- Consumers' level of income, M.
- Number of consumers, C.
- Customers' tastes and preferences, T.

Using mathematical notation, we can present the following function:

$$x_i = f(p_i, p_1, \ldots\ldots, p_n, M, C, T) \quad (1)$$

Theoretically, two types of demand functions are

distinguishable - individual and systemic. As the names imply, there is only one function in the first while in the second there is a collection or system of functions. The advantage of the second is that the Slutsky relations, budget limitations, homogeneity, and so on, all create constraints the testing or creation of which is not possible in the case of individual functions. There is also a secondary classification in the second category that enables differentiating between functions derived from a specific utility function and those not found so; AIDS belongs to this second category. Essentially, there are two approaches to estimate the demand functions' variables: One is to estimate a single-equation demand function without recourse to economic theories, and the other is to make use of the demand theory in determining the equations forms and selecting the variables. In the second, we first derive the forms of the demand equations from the mathematical patterns of the consumers' behavior and then impose some constraints on the variables; this way, we can both estimate the independent variables as well as reduce the required data. AIDS is of this type, and because of its coordination with the mentioned theory and its flexibility in presenting elasticity, it has become very popular with the researchers.

3.1. Empirical Model

The AIDS was first established in 1980 by Deaton and Muellbauer. The model begins with a set of defined cost functions called PIGLOG the general form of which is as follows:

$$\text{Ln } a(p) = a. + \sum_{k=1}^{n} a_k . \ln p_k + \frac{1}{2} \sum_{j=1}^{n} Y_{kj} . \ln p_k . \ln p_j \quad (2)$$

$$\text{Ln } b(p) = \ln a(p) + \beta . \Pi_{k=1}^{n} p_k^{\beta_k} \quad (3)$$

Using the above functions, the PIGLOG cost function will be as follows:

$$\text{Ln } c(u,p) = a_0 + \sum_{k=1}^{n} a_k . \ln p_k + \frac{1}{2} \sum_{k=1}^{n} \sum_{j=1}^{n} Y_{kj} . \ln p_j + u \beta_0 \Pi_{k=1}^{n} p_i^{\beta_k}$$

And, considering Shepherd's lemma, we have:

$$\frac{\partial \ln c(u,p)}{\partial \ln p_i} = W_i = a_i + \sum_{j=1}^{n} Y_{ij} \ln p_j + u\beta . \beta_i \Pi_{k=1}^{n} p_k^{\beta_k} \quad (4)$$

Since the total costs c (u,p) equal the total income M, if we can derive c(u,p) = M based on M and p, we will obtain the indirect utility function through which the uncompensated demand function will be found as follows:

$$W_i = a_i + \sum_{j=1}^{n} Y_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{P^*}\right), \; i = 1,2,3,4,5 \quad (5)$$

The above equation represents the AIDS system of functions the constraints of which are as follows:

$$\sum_{i=1}^{n} a_{i=1}, \sum_{i=1}^{n} Y_{ij=0}, \sum_{i=1}^{n} \beta_{i=0} \quad \text{(Collectivity constraint)} \quad (6)$$

$$\sum_{j=1}^{n} Y_{ji=0} \quad \text{(Homogeneity constraint)} \quad (7)$$

$$Y_{ij} = Y_{ji} \quad \text{(Symmetry constraint)} \quad (8)$$

Upon estimating the coefficients of the above system, the income and cross-elasticity can be calculated using the following equations (Green and Alston, 1991):

$$\eta_{im} = 1 + \frac{\beta_i}{W_i} \quad \text{(Income elasticity)} \quad (9)$$

$$\varepsilon_{ii} = -1 + \frac{Y_{ij}}{W_i} - \beta_i \quad \text{(Own price elasticity)} \quad (10)$$

$$\varepsilon_{ij} = \frac{Y_{ij}}{W_i} - \beta_i \frac{W_j}{W_i} \quad \text{(Price cross-elasticity)} \quad (11)$$

$$\zeta_{ij} = \varepsilon_{ij} + W_j \eta_{im} \quad \text{(Compensated price cross-elasticity)} \quad (12)$$

$$\zeta_{ij} = \varepsilon_{ii} + W_j \eta_{im} \quad \text{(Compensated own price elasticity)} \quad (13)$$

In calculating all the elasticity figures, use has been made of the average of the shares during the study period.

4. DATA AND METHODOLOGY

The data utilized in the present study include those of the urban and rural household budgets gathered by the "Central Bank of the Islamic Republic of Iran" and the "National Statistical Center" during the period 1991-2012. The electricity consumption share of expenses has been separately calculated, using the raw data of the household budget, and has entered the model as a dependent variable. The information regarding the price of the electrical energy carrier in the domestic sector has been gathered from the National Energy Balance Sheet, and the indices of goods and services in the urban and rural areas have been collected from the sites of the above mentioned authorities. With the above information and data, we estimated the demands for five commodity groups ("electricity," "food and tobacco," "shoes and clothing," "housing," and "other goods"), calculated the related elasticity figures, and analyzed the results using AIDS and seemingly unrelated regression (SUR) techniques. To calculate the expense share of the "other goods," use was made of the average value of the expenses of the health and medical care, transportation, communication, recreation, cultural affairs, education, furniture, and miscellaneous services. In this paper, results have been presented for urban and rural sectors separately.

Using the AIDS, equations for the above five commodity groups are as follows:

$$W_b = a_1 + \gamma_{11} \ln p_b + \gamma_{12} \ln p_{kh} + \gamma_{13} \ln p_p + \gamma_{14} \ln p_m + \gamma_{15} \ln p_c + \beta_1 \ln (m/p^*)$$

$$W_{kh} = a_2 + \gamma_{21} \ln p_b + \gamma_{22} \ln p_{kh} + \gamma_{23} \ln p_p + \gamma_{24} \ln p_m + \gamma_{25} \ln p_c + \beta_2 \ln (m/p^*)$$

$$W_p = a_3 + \gamma_{31} \ln p_b + \gamma_{32} \ln p_{kh} + \gamma_{33} \ln p_p + \gamma_{34} \ln p_m + \gamma_{35} \ln p_c + \beta_3 \ln (m/p^*)$$

$$W_m = a_4 + \gamma_{41} \ln p_b + \gamma_{42} \ln p_{kh} + \gamma_{43} \ln p_p + \gamma_{44} \ln p_m + \gamma_{45} \ln p_c + \beta_4 \ln (m/p^*)$$

$$W_c = a_5 + \gamma_{51}\ln p_b + \gamma_{52}\ln p_{kh} + \gamma_{53}\ln p_p + \gamma_{54}\ln p_m + \gamma_{55}\ln p_c + \beta_5 \ln (m/p^*)$$

Where W_b, W_{kh}, W_p, W_m, and W_c are respectively the electricity, food and tobacco, shoes and clothing, housing, and other goods expense shares of the total household budget, and p_b, p_{kh}, p_p, and p_m are respectively the electricity, food and tobacco, shoes and clothing, and housing price indices.

The expense share of "other goods" includes those of the health care, transportation, communications, cultural and recreational activities, education, furniture, and miscellaneous services, and its price is calculated through the weighted average of the above groups found from the following equation:

$$P_C = \frac{W_D P_D + W_H P_H + W_A P_A + W_T P_T + W_{TA} P_{TA} + W_S P_S + W_{MO} P_{MO}}{W_D + W_H + W_A + W_T + W_{TA} + W_S + W_{MO}} \quad (14)$$

Where W_{MO}, W_S, W_{TA}, W_T, W_H, W_A, and W_D are respectively the health and medical care, transportation, communications, recreational and cultural activities, education, furniture, and miscellaneous services expense shares of the total household budget, M is total household budget, and P* is the stone price index found as follows:

$$\ln p^* = \sum_{j=1}^{n} w_j \ln p_j p^* \quad (15)$$

The above equation enables multistage budgeting based on the assumption of "weak separability of preferences." Here, the customers first allocate their total budget to main groups of goods and services, and then, considering the related prices, decide on the amount of the commodities they need within each group.

To determine the system of the demand equations, use can be made of the SUR method (Zellner, 1962) because of the correlation between the residuals of the demand function or share of the expenses. Another advantage of the SUR over the ordinary least squares (OLS) method is its higher efficiency of the estimators; the higher is the correlation between the residuals, the more efficient is the SUR. The point worth noting is that if there were not any model constraints among different equations, SUR estimations would not differ much from those of OLS (Johnston, 1998).

To examine the homogeneity and symmetry constraints with the SUR method, the model is tested unrestrictedly using the Wald test; if the restrictions are rejected, they are imposed on the model and it is estimated restrictedly.

5. RESULTS

To calibrate the model and estimate the AIDS parameters, we first estimated the unconstrained equations for four commodity groups for the urban households and then tested the homogeneity and symmetry constraints separately (Tables 1-3). If the homogeneity assumption is accepted, the model will be estimated with this constraint. The symmetry assumption is then checked through testing the related constraint and, if necessary, the model is estimated with both constraints. Unlike homogeneity, the symmetry constraint cannot be tested for individual equations; it should be tested simultaneously for the entire system (Deaton and Muellbauer, 1980).

Table 1: Homogeneity constraint test results for the urban households

Demand equations	Chi-square	P	Monetary illusion results
Electricity	0.0064	0.936	Lack
Food and tobacco	8.65	0.0033	Existence
Shoes and clothing	2.62	0.105	Lack
Other goods	0.0068	0.934	Lack

Source: Present study, Statistical Centre of Iran, Raw statistics on households budget and statistical year books, 1991-2012 periods.

Table 2: Symmetry constraint test results for the urban households

Symmetry relationship	Chi-square	P	Result
All commodity groups considered simultaneously	20.78	0.002	Rejected

Source: present study, "Statistical Centre of Iran, Raw Statistics on Households Budget and Statistical Year Books, 1991-2012 Periods.

The acceptance of the symmetry constraint indicates that the price coefficient of the jth commodity in the equation for the share of the ith commodity is equal to that of the ith commodity in the equation representing the share of the jth commodity; in other words, the demand change for one commodity due to a unit change in the price of other commodities (compensated for income), is equal to the demand changes for other commodities because of a unit change in the price of the first commodity. The symmetry constraint for AIDS functions is shown as $Y_{ij} = Y_{ji}$, and the reasons for rejecting the symmetry assumption include the synergy between commodities, exogenous assumption of the income and prices, static assumption of the decision-making process, and so on.

Wald test results for the urban family shows that the homogeneity assumption cannot be rejected for such groups as the "electricity," "shoes and clothing," and "other goods" at a probability level of 0.01, but it can for the "food and tobacco" group; accepting it means that there is no monetary illusion. Regarding the symmetry assumption, Wald test results indicate its rejection; therefore, share equations for the urban family are estimated with the homogeneity constraint.

Since direct interpretations of the parameters estimated by the AIDS model are not possible, and because the dependent and independent variables in the AIDS equations are respectively the expense share of commodity groups in the household budget, and the logarithm of the price indices of the commodity groups and the household budget, it is necessary to calculate the demand elasticity in order to evaluate the sensitivity of the demand to the changes in the price of the commodity groups. Table 4 shows the uncompensated, compensated, and urban household expenditure elasticity calculation results.

Results from homogeneity tests for rural households, using the t-statistics, indicate that we cannot reject the null hypothesis for

Table 3: Homogeneity constrained coefficients for the urban households demand equations

Equation and coefficients	Electricity		Food and tobacco		Shoes and clothing		Housing		Other goods	
Intercept	0.102	−19.32	−0.034*	(−0.29)	−0.119	(−2.76)	−0.09	-	1.15	7.09
Electricity	0.007	(16.98)	0.008*	−0.09	−0.007	(−2.0)	−0.023	-	0.022	(1.85)
Food and tobacco	0.0014*	(−1.32)	0.127	(6.02)	−0.0014	(−1.57)	0.11	-	−0.23	(−7.1)
Shoes and clothing	−0.004	(−3.82)	0.034	(1.53)	0.05	(5.6)	0.06	-	−0.14	(−4.22)
Housing	−0.0014	(−1.74)	−0.129	(−8.45)	−0.016	(−2.47)	0.052	-	0.093	(3.87)
Other goods	0.00013	-	−0.033	-	−0.014	–	0.63	-	−0.58	-
Expenses	−0.007	(−17.9)	0.029	(3.17)	0.014	(4.29)	0.033	-	−0.07	(−5.63)
	-	-	-		-		-		-	
R^2	0.93		0.98		0.98		-		0.95	
Durbin-Watson coefficient	2.3		1.76		2.28		-		2.3	

Source: Present study, Statistical Centre of Iran, Raw Statistics on Households Budget and Statistical Year Books, 1991-2012 Periods. figures in parenthesis show the t-statistic. *These coefficients are not statistically meaningful

Table 4: Elasticity for urban household demand

Commodity group	Uncompensated elasticity (Marshall)					Compensated elasticity (Hicks)					Expenditure elasticity
	Electricity	Food and tobacco	Clothes and shoes	Housing	Other commodities	Electricity	Food and tobacco	Clothes and shoes	Housing	Other commodities	
Electricity	−0.134	-	−0.45	0.07	0.16	−0.133	-	−0.44	0.09	0.19	0.1
Food and tobacco	-	−0.59	0.11	−0.47	−0.15	-	−0.27	0.19	−0.17	0.14	1.1
Clothes and shoes	−0.096	−0.25	−0.28	−0.29	−0.28	−0.09	0.09	−0.20	0.044	0.15	1.2
Housing	−0.08	0.39	0.21	−0.84	2.23	−0.073	0.72	0.29	−0.53	2.52	1.12
Other commodities	0.064	−0.59	−0.38	0.31	−2.55	0.07	−0.36	−0.32	0.53	−2.26	0.81

Source: Present study. Statistical centre of Iran, Raw statistics on households budget and statistical year books, 1991-2012 Periods.

the food and tobacco, and clothes and shoes at 1% probability level while we can for electricity and other goods (Table 5). Accepting the homogeneity constraint would mean there is no monetary illusion present. Of course, it should be noted that the AIDS functions have not been derived from a specific utility function, so the hypothesis may be rejected. In many empirical studies done both inside and outside Iran, rejection of the homogeneity assumption has been reported for a variety of reasons like the use of stone index instead of the actual price index, culture, language, season, race, and so on (Table 6). Results from the symmetry hypothesis test for the rural family, using Wald test, show that this hypothesis is rejected; therefore, the equations for rural family share are estimated with the homogeneity restriction (Table 7).

Since direct interpretations of the parameters estimated by the AIDS model are not possible, and because the dependent and independent variables in the AIDS equations are respectively the expense share of commodity groups in the rural household budget, and the log of the price indices of the commodity groups and the rural household budget, it is necessary to calculate the demand elasticity in order to evaluate the sensitivity of the demand to the changes in the prices of the commodity groups. Table 8 shows the uncompensated, compensated, and urban household expenditure elasticity calculation results.

6. DISCUSSION

6.1. Urban Households

In computing all the elasticity values, we have used the average of the shares during the study period. As shown (Table 4), the expenditure elasticity shows that with 1% increase in the total family expenditure, the shares of the "electricity," "food and tobacco," "clothes and shoes," "housing," and "other goods" categories increase by 0.1, 1.1, 1.2, 1.12, and 0.81% respectively. It should be noted that, in the AIDS, classifying goods to "necessary" and "luxury" is made according to signs of the true expenditure coefficients; positive sign means "luxury" and negative means "necessary" because, since w_i is always positive, if β_i is negative, then $\eta_i < 1$, and if it is positive, then $\eta_i > 1$.

Table 5: Test of homogeneity assumption for the rural households

Demand equations	Chi-square	P	Result (monetary illusion)
Electricity	15.10	0.0001	Exists
Food and tobacco	0.039	0.844	Lacks
Clothes and shoes	1.86	0.173	Lacks
Other goods	14.83	0.0001	Exists

Source: Present study, Statistical Centre of Iran, Raw Statistics on Households Budget and Statistical Year Books, 1991-2012 Periods.", " National Iranian Center for Statistics, Surveys of Price Indexes and Expenditure/Income for the Rural Households for 1991-2012.

Table 6: Test of symmetry assumption for the rural households

Symmetry relationship	Chi-square	P	Result
All commodity groups considered simultaneously	38.62	0.00	Rejected

Source: Present study, Statistical Centre of Iran, Raw Statistics on Households Budget and Statistical Year Books, 1991-2012 Periods.", "National Iranian Center for Statistics, Surveys of Price Indexes and Expenditure/Income for the Rural Households for 1991-2012.

Table 7: Estimation of coefficients for the rural households demand equation using the homogeneity assumption

Equation and coefficients	Electricity		Food and tobacco		Clothes and shoes		Housing		Other commodities	
Intercept	0.056	−4.43	0.34	−29.97	0.046	(11.67)	0.126	-	0.43	(48.04)
Electricity	0.0094	(4.07)	0.021	−1.63	−0.021	(−2.13)	0.38	-	−0.049	(−4.18)
Food and tobacco	−0.017	(−3.62)	0.17	−5.92	−0.0055*	(−0.14)	0.083	-	−0.24	(−7.78)
Clothes and shoes	−0.01	(−1.46)	0.004*	(0.097)	0.038	(3.44)	0.075	-	−0.11	(−2.75)
Housing	0.009*	−1.45	−0.15	(−5.06)	−0.031	(−3.37)	0.013	-	0.16	(5.77)
Other commodities	0.084	-	−0.046	-	0.018	-	−0.21	-	0.23	-
Expenses	−0.0068	(−3.76)	0.022	−8.72	0.016	−18.04	0.00008	-	−0.031	(−16.8)
R^2										
Durbin Watson Coefficient	0.9		0.96		0.98		-		0.98	
	2.15		1.89		1.66		-		2	

Source: Present study, Statistical Centre of Iran, Raw Statistics on Households Budget and Statistical Year Books, 1991-2012 Periods.", "National Iranian Center for Statistics, Surveys of Price Indexes and Expenditure/Income for the Rural Households for 1991-2012." Figures within parenthesis are the t Statistics, figures within parenthesis are the t-statistics. *These coefficients are not statistically significant

Table 8: Elasticity for rural household demand

Commodity group	Uncompensated elasticity (Marshall)					Compensated elasticity (Hicks)					Expenditure elasticity
	Electricity	Food and tobacco	Clothes and shoes	Housing	Other commodities	Electricity	Food and tobacco	Clothes and shoes	Housing	Other commodities	
Electricity	−0.14	−1.24	−0.83	-	0.96	−0.134	−1.08	−0.79	-	1.08	0.37
Food and tobacco	0.05	−0.62	-	−036	−0.11	0.06	−0.17	-	−0.21	0.22	1.05
Clothes and shoes	−0.18	-	−0.65	−0.34	0.094	−0.17	-	−0.54	−0.17	0.46	1.21
Housing	0.26	0.55	0.54	−0.91	−2.07	0.27	0.98	0.65	−0.76	−1.80	1.0
Other commodities	−0.15	−0.70	−0.32	0.52	−0.24	−0.14	−0.32	−0.23	0.65	0.042	0.90

Source: Present study, Statistical Centre of Iran, Raw Statistics on Households Budget and Statistical Year Books, 1991-2012 Periods.", "National Iranian Center for Statistics, Surveys of Price Indexes and Expenditure/Income for the Rural Households for 1991-2012

Results show that food and tobacco, clothes and shoes, housing categories have positive (>1) expenditure elasticity, i.e., with an increase in the total household budget, their shares will increase with a greater rate. Electricity and other goods too have positive (but <1) expenditure elasticity, i.e., with an increase in the total household budget the shares of these commodities will increase with a smaller rate; the conclusion is that electricity is a necessary commodity for the urban households.

In the Table, the diagonal entries indicate the own price elasticity whereas the non-diagonal ones show the cross elasticity. A review of the own price elasticity shows that for all five commodity groups the price elasticity is negative meaning that, as expected, there is a negative relation between the demand and price. As shown, the price elasticity for "electricity," "food and tobacco," "clothes and shoes," "housing," and "other goods" are −0.13, −0.59, −0.28, −0.84, and −2.55 respectively, meaning that 1% increase in the price of the above mentioned commodities, there will respectively be 0.13, 0.59, 0.28, 0.84, and 2.55% decrease in their demand. Since their absolute values are <1, the demand function for them is inelastic.

The positive sign of the cross-elasticity is an indication that two commodities are substitutable whereas the negative sign shows that the two are complementary. It is to be noted, when interpreting the table figures, that the rows show the impact of the price changes on the demand for the group itself and for other groups as well.

In the first row, ε_{12}, ε_{13}, ε_{14}, and ε_{15} show respectively from left to right the cross-elasticity of electricity with food and tobacco, clothes and shoes, housing, and other goods; therefore, we can say that 1% increase in the price of electricity, will cause 0.45% decrease in the demand for clothes and shoes, 0.07% increase in the demand for housing, and 0.16% increase in the demand for other goods. Also, because the price log of the food and tobacco is insignificant in the electricity demand equation, the elasticity for it is meaningless meaning that electricity expenditure has no or little impact on the food and tobacco expenditure.

In the second row, ε_{21}, ε_{23}, ε_{24}, and ε_{25} show respectively from left to right the cross-elasticity of food and tobacco with electricity, clothes and shoes, housing, and other goods; therefore, we can say that 1% increase in the price of food and tobacco will cause 0.11% increase in the demand for clothes and shoes, 0.47% decrease in the demand for housing, and 0.15% decrease in the demand for other goods. Also, because the price log of the electricity is insignificant in the food and tobacco demand equation, the elasticity for it is meaningless meaning that electricity expenditure has no or little impact on the food and tobacco expenditure.

In the third row, ε_{31}, ε_{32}, ε_{34}, and ε_{35} show respectively from left to right the cross-elasticity of clothes and shoes with electricity, food and tobacco, housing, and other goods; therefore, we can say that 1% increase in the price of clothes and shoes will cause 0.096% decrease in the demand for electricity, 0.25% decrease in the demand for food and tobacco, 0.29% decrease in the demand for housing, and 0.09% decrease in the demand for other goods.

In the fourth row, ε_{41}, ε_{42}, ε_{43}, and ε_{45} show respectively from left to right the cross-elasticity of housing with electricity, food and tobacco, clothes and shoes, and other goods; therefore, we can say

that 1% increase in the price of housing will cause 0.08% decrease in the demand for electricity, 0.39% increase in the demand for food and tobacco, 0.21% increase in the demand for clothes and shoes, and 2.23% increase in the demand for other goods.

In the fifth row, ε_{51}, ε_{52}, ε_{53}, and ε_{55} show respectively from left to right the cross-elasticity of the other goods with electricity, food and tobacco, clothes and shoes, and housing; therefore, we can say that 1% increase in the price of other goods will cause 0.064% increase in the demand for electricity, 0.59% decrease in the demand for food and tobacco, 0.38% decrease in the demand for clothes and shoes, and 0.31% increase in the demand for housing.

Results from the calculation of the Hicks elasticity are almost the same as those of the Marshall's. For instance, with 1% increase in the uncompensated electricity price, its demand will decrease by 0.134%, but in the compensated case, the decrease will be 0.132%, i.e., if the income effect is compensated, there will be less decrease in demand due to the price increase. It is worth noting that this is not calculable for inferior commodities.

The slope of the compensated demand function is more than that of the ordinary one and therefore it shows less elasticity. In fact, the consumer compensated demand function is derived through eliminating the income effect and compensating for the income to remain at the same level of utility. Hence, if this is done, we can see that, according to the compensated demand function, the demand sensitivity to price changes will decrease compared with the ordinary demand. The absolute value of the Marshall's uncompensated own price elasticity is greater than the Hicks's compensated own price elasticity conforming to the theory that says the consumer's reaction against the price changes of the commodity itself is higher when the income is not compensated.

6.2. Rural Households

As shown in Table 8, expenditure elasticity for "electricity," "food and tobacco," "clothes and shoes," "housing," and "other goods" for rural households are respectively 0.37, 1.05, 1.15, 1.0, and 0.90 meaning that for every 1% increase in the total rural family expenditure, the shares of the above commodity groups will increase by 0.37, 1.05, 1.15, 1.0, and 0.9% respectively.

Results indicate that "food and tobacco" and "clothes and shoes" have positive (>1) expenditure elasticity meaning that with an increase in the total rural family expenditure, the shares of these commodities will be greater. The "electricity" and "other goods" have positive (but <1) expenditure elasticity which means that with an increase in the total rural family expenditure, the shares of these commodities will be smaller. The electricity expenditure elasticity equals 1 concluding that for rural families too, the electricity is a necessary and basic need.

In the table, the diagonal entries indicate the own price elasticity whereas the non-diagonal ones show the cross elasticity. A review of the own price elasticity shows that for all commodity groups (except "electricity") the price elasticity is negative meaning that there is, as expected, a negative relation between the demand and price. As shown, the price elasticity for "electricity," "food and tobacco," "clothes and shoes," "housing," and "other goods" are respectively −0.139, −0.61, −0.65, −0.91, and −0.24 meaning that with 1% increase in the price of the above mentioned commodities, there will respectively be 0.139, 0.61, 0.65, 0.91, and 0.24% decrease in their demand. Since their absolute values are <1, the demand function for them is inelastic. It is to be noted, when interpreting the Table figures for cross-elasticity, that the rows show the impact of the price changes on the demand for the group itself and for other groups as well.

In the first row, ε_{12}, ε_{13}, ε_{14}, and ε_{15} show respectively from left to right the cross-elasticity of electricity with "food and tobacco," "clothes and shoes," housing, and other goods; therefore, we can say that 1% increase in the price of electricity, will cause 1.24% increase in the demand for food and tobacco, 0.83% decrease in demand for clothes and shoes, and 0.96% decrease in the demand for other goods. Also, because the price log of the housing is insignificant in the electricity demand equation, no cross-elasticity is calculated for it meaning that housing expenditure has no or little impact on the electricity expenditures of the rural households.

In the second row, ε_{21}, ε_{23}, ε_{24}, and ε_{25} show respectively from left to right the cross-elasticity of food and tobacco with electricity, clothes and shoes, housing, and other goods; therefore, we can say that 1% increase in the price of food and tobacco will cause 0.05% increase in the demand for electricity, 0.36% decrease in the demand for housing, and 0.11% decrease in the demand for other goods. Also, because the price log of clothes and shoes is insignificant in the food and tobacco demand equation, no cross-elasticity is calculated for it meaning that the clothes and shoes expenditure has no or little impact on the food and tobacco expenditures of the rural households.

In the third row, ε_{31}, ε_{32}, ε_{34}, and ε_{35} show respectively from left to right the cross-elasticity of clothes and shoes with electricity, food and tobacco, housing, and other goods; therefore, we can say that 1% increase in the price of clothes and shoes will cause 0.18% decrease in the demand for electricity, 0.34% decrease in the demand for housing, and 0.094% increase in the demand for other goods. Also, because the price log of foods and tobacco is insignificant in the clothes and shoes demand equation, no cross-elasticity is calculated for it meaning that the food and tobacco expenditure has no or little impact on the clothes and shoes expenditures of the rural households.

In the fourth row, ε_{41}, ε_{42}, ε_{43}, and ε_{45} show respectively from left to right the cross-elasticity of housing with electricity, food and tobacco, clothes and shoes, and other goods; therefore, we can say that 1% increase in the price of housing will cause 0.26% increase in the demand for electricity, 0.55% increase in the demand for food and tobacco, 0.54% increase in the demand for the clothes and shoes, and 2.07% decrease in the demand for other goods.

In the fifth row, ε_{51}, ε_{52}, ε_{53}, and ε_{55} show respectively from left to right the cross-elasticity of the other goods with electricity, food and tobacco, clothes and shoes, and housing; therefore, we can say that 1% increase in the price of other goods will cause 0.15% decrease in the demand for electricity, 0.7% decrease in the demand

for food and tobacco, 0.32% decrease in the demand for clothes and shoes, and 0.51% increase in the demand for housing.

Results from the calculation of the Hicks elasticity are almost the same as those of the Marshall's. The absolute value of the uncompensated (Marshall) own price elasticity figures are greater than the compensated (Hicks) ones which conforms to the theory that says the consumers reactions against the changes and prices of the commodities themselves are higher when the income is not compensated. For instance, with 1% increase in the uncompensated electricity price, its demand will decrease by 0.139% whereas it is 0.134% when compensated.

In order to further investigate the impact of government cash subsidies on the energy consumption, we calculated the ordinary own price (Marshall) elasticity and income elasticity for both urban and rural households. For the urban family, price elasticity for the years 2011 and 2012 were respectively −0.32 and −0.16, and the income elasticity for the same years were 0.29 and 0.12. The results clearly indicate that after a short-term shock due to the subsidies, the demand and consumption levels return to the previous state before the subsidies. The electric consumption by urban households shows a temporary decrease during the first year after the subsidies, and returns back to where it was before and even increases during the second year following the subsidies. These findings make sense because urban households cannot alter their consumption behavior for electricity or drastically change their housing condition and replace their high energy consuming old appliances with the new and energy efficient ones in the short run. As a result, with a price decrease shock, the consumption first declines and then increases again.

In the case of rural households, the calculated ordinary own price elasticity for 2011 and 2012 were −0.40 and −0.24 and the income elasticity for the same years were 0.56 and 0.45. These results too can be interpreted in a similar way; the main difference is that with the implementation of the cash subsidies during 2011 (which actually increased the previous prices drastically), most poor rural households in cold regions resorted to cutting the trees and bushes and burning them instead of clean energy sources, and these, according to the "National Environmental Protection Agency" reports had its own adverse and damaging environmental impacts. In 2011, following the removal of the energy subsidy by the government, demand for electricity by the rural households experienced a sharper decline than that by the urban families.

7. CONCLUSIONS AND POLICY IMPLICATIONS

The ever-increasing consumption of electricity in Iran which is mainly due to its low and, in fact, unrealistic price, has already put tremendous pressure on the country's power supply network, making it very difficult to plan for and manage the electricity supply and demand. The optimum and realistic pricing policies with economic justification are, therefore, urgently needed to balance the current supply and demand and allow for future planning of demand by proper investments in expanding the generation, transmission, and consumption of electricity. Domestic electricity consumption is the biggest and the most important component of the total demand for electricity and measures are to be taken for its optimization without further delay. The present study has focused on the impact of the government targeting subsidies on the domestic electricity consumption, using the AIDS as the main method. Data of the price indexes and expenditures for urban and rural families required for the study have been obtained from the National Center for Statistics, Central Bank of the Islamic Republic of Iran, and the Balance Sheets of the years 1991-2012. For the estimation of the demand and price elasticity values, use has been made of the SUR method.

The research results have shown that the expenditure (income) elasticity for urban and rural families is positive and <1 and the price elasticity for electricity for the mentioned families is negative and <1. Since electricity in modern life is more of a necessity than a luxury, the results have implications for policy making. The absolute value of the electricity price elasticity is <1; hence, a price change will not highly affect the consumption level. Therefore, in addition to pricing, such complementary policies as encouraging the public to save energy and use more efficient electric appliances (bulbs, heating, and air conditioning) are also necessary. Electricity is a basic commodity for both the urban and rural families; therefore, the price increase (as a result of targeting subsidies) will put more pressure on the rural than on the urban family causing their welfare to suffer. More supportive policies are, therefore, required for the rural families if the government increases the electricity price. To improve the electricity consumption pattern, the government should adopt a combination of policies like implementing the increasing block tariff, identifying the poor and vulnerable and increasing their subsidies while simultaneously eliminating those of the rich, and finally preventing the production and importation of high energy consuming electric appliances.

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