The Pakistan Development Review
47 : 4 Part II (Winter 2008) pp. 457–467

Residential Demand for Electricity in Pakistan

MUHAMMAD NASIR, MUHAMMAD SALMAN TARIQ, and ANKASHA ARIF

1. INTRODUCTION

Undoubtedly, in the new millennium, the importance of energy sector for the development of a country is undeniable. Rapidly increasing knowledge along with speedy technological innovation has resulted in the provision of abundance of facilities. This has made the human beings, consumers or producers, much demanding for energy sources that are used to run mechanical processes. There are various sources of energy which include oil, electricity, gas, coal and nuclear. Countries differ in the usage of alternative energy sources. In Pakistan the major energy source is gas which is 41 percent of the total energy supplied. The other energy supply sources along with their percentage shares are as follow: oil (29 percent), hydro (12.70 percent), coal (12 percent) and nuclear (1 percent).[1]

Electricity is one of the most important source of energy in Pakistan. It has become a necessity in the present life, having a wide range of uses in residential as well as in commercial sector. Table 1 describes the major domestic users of electricity in Pakistan along with their respective shares of consumption. It is obvious from the table that residential consumption of electricity has the highest share. This clearly shows the

Table 1

Consumption of Electricity 2008

Sector	Percentage Share
Household	45.6
Commercial	7.4
Industrial	28.4
Agriculture	11.8
Street Light	0.6
Other Govt.	6.2

Source: Pakistan Economic Survey, 2007-08.

Muhammad Nasir <nasirawan84@yahoo.com> is Lecturer, Department of Economics, Kohat University of Science and Technology, Kohat. Muhammad Salman Tariq <salmantariq@gmail.com> is Student, Pakistan Institute of Development Economics, Islamabad and Ankasha Arif <ankashaarif@hotmail.com> is Student, Department of Economics, Quaid-i-Azam University, Islamabad.

Authors' Note: We are thankful to Wasim Shahid Malik, Mahmood Khalid, Ahsan ul Haq Satti, Faryal Qayyum and Rashid Ali for their help and encouragement.

[1] These values are obtained from *Pakistan Economic Survey (2007-08).*

dependence of the households on electric appliances in their daily life. Households mainly use electricity for refrigerating, cooling, washing and entertainment purposes, since due to huge reserves and low price, cooking and heating are mostly done by natural gas. Due to rapid increase in technological innovations together with the growth in domestic electric appliances industry has made it affordable for more people to use these cheaper electric appliances in their daily work.

Unfortunately, for about a year now, Pakistan is facing the worst energy crisis of her history. On one hand, the increase in the oil prices at the world level is severely affecting the common masses; on the other hand, the shortage of electricity is creating havoc in the country. In order to cope with this situation the government is taking various measures. It is doing extensive load-shedding all over country which ranges from 8 to 16 hours a day. It has tried to save daylight by moving the time an hour ahead but this practice is not helping much. In addition, per unit price increase is also on a move. Nevertheless, all these steps may only be considered as nominal which may not be fruitful in the current crisis. This shortage of electric power may be the result of higher demand or lesser supply or both. Our focus, however, in this study is limited to the demand side of the issue.

Beside others, one important reason that is advocated for this shortage is the rise in electricity demand due to increase in production as well as rise in household income. In this sense, this electricity shortage is presented as a colored side of the picture instead of black one. To investigate the reality of this claim, it would be interesting to find out the income elasticity of electricity demand. Furthermore, it is believed that increasing the unit price of electricity will reduce the electricity demand. That is why the unit prices of electricity vary with different range of unit usage. So price elasticity is calculated as well. In addition, high population growth is also considered an important factor for increase in electricity demand. Hence, the objective of this paper is to calculate income, price, and household size elasticities of electricity demand for Pakistan using time series data from 1979 to 2006.[2] Moreover, in order to capture the variation in prices charged for different ranges of unit usage, we also constructed a price index for electricity for this study.

2. LITERATURE REVIEW

The literature on residential demand for electricity is very rich and can be traced back to 1950s. Different researchers conducted various studies to estimate the short run and long run income and price elasticities of electricity demand. Among them, Houthakker (1951) in his paper studies the U.K residential electricity demand for 42 provincial towns from 1937 to 1938. Using double logarithmic model the study estimates an income elasticity of 1.17, price elasticity of –0.89 and a cross elasticity of 0.21. However, it is difficult to infer from the study that these are short run or long run elasticities. Fisher and Kaysen (1962) studies residential and industrial electricity demand for U.S. The data set consists of 47 states from 1946 to 1957. Results, however, show that price has a little influence on long run electricity demand. In a similar study, Houthakker and Taylor (1970) estimates both the short run and long run elasticities of the domestic consumption of electricity for period 1947-1964. The short run income and price

[2]We did not take the year 2007 due to tremendous fluctuation in electricity prices which could severely affect our results.

elasticities are 0.13 and –0.13 respectively. The respective long run income and price elasticities are 1.93 and –1.89.

Although income elasticity is expected to have positive sign theoretically and this infact is observed in almost all empirical studies regarding electricity demand, Wilson (1971) finds negative income elasticity along with negative price elasticity. The negative income elasticity, –0.46**,** suggests that electricity is an inferior good. The price elasticity comes out to be –1.33. The study uses cross sectional data for 77 cities to find residential demand for electricity. Variables used are average electricity consumption per house hold, price of electricity, average price of natural gas, medium family income, and average number of rooms per household and number of degree days. Estimations are done by using linear and log-linear models. Similarly, Mount, *et al*. (1973) investigates residential, commercial and industrial electricity demand using pooled cross sectional and time series data from 1947 to1970 for 47 states. Least square and instrumental variable techniques are used to estimate income, own price and cross price elasticities. The results of least square technique show that residential short run and long run income elasticities are 0.02 and 0.20, price elasticities as –0.14 and –1.20 whereas cross elasticities with respect to price of gas as 0.02 and 0.19 respectively.

Anderson (1973) analyses residential electricity demand for years 1960 and 1970 of 50 states. The study uses two models, one for the prediction of stock of equipment that uses energy and other for the utilisation of energy. In the utilisation of energy model, double log model is used. Direct and indirect estimations are done showing the results of price elasticity to be –1.12 and 0.28 respectively**.** In a different study, Houthakker, *et al*. (1973) studies time series and cross sectional data to find residential demand for electricity for years 1960 to 1971 for 48 states. Making use of Error Correction Model, two estimations are done. In first estimation marginal rates in 100-250 Kwh are taken into account while in other marginal rates in 100-500 Kwh are considered for the data of price. First estimation (of 100-250Kwh block) results show that short run income elasticities is 0.15 and long run income elasticity is 2.20, whereas the short run and long run price elasticities are –0.03 and –0.44 respectively. Results of second estimations (of 100-500 Kwh block) show that short run and long run income elasticities are 0.14 and 1.64 respectively. While the respective short run and long run price elasticities are –0.09 and –1.02. Halvorsen (1975) uses pooled data of 48 states of America from 1961 to 1969 to investigate residential demand for electricity. Using two staged least square (2SLS) method for estimations, the study concludes that the own price elasticity is between –1.00 to –1.21. The estimated direct income elasticities are all with in the range of 0.47 to 0.54, whereas the cross price elasticity (with respect to gas price) ranges from 0.04 to 0.08.

Hsiao and Mountain (1985) studies the income elasticity of electricity demand by using cross sectional data for the Ontario province, Canada. Conditional mean method and Pseudo-instrumental variable method are used to find short run income elasticities by using different variables. Income elasticity comes out to be 0.1614 in Conditional mean method and 0.1740 in pseudo-instrumental mean. Filippini (1999) investigates residential demand for electricity for Switzerland using data of 48 cities form 1987-1990. Using the variables residential consumption of electricity per city in Kwh, electricity price index, household personal income, household size, number of households in city, heating degree days and dummy for all households who face two part time tariffs, the OLS model estimates income and price elasticities as 0.391 and –0.595 respectively.

Although most of the literature concentrates on the estimated elasticities**,** Bentzen and Engsted (2001) focuses on the techniques used for such estimation. The study compares the results of the ARDL model with cointegration methods and ECM. It finds no big difference and concludes that after fulfilling some requirements, the ARDL model gives valid results and can be used for estimating energy demand relationship, as was the tradition in studies till late1980s. Filippini and Pachauri (2002) investigates income and price elasticities in Indian urban areas for the seasons of winter, monsoon and summer. Data of 30972 households is used from household expenditure survey for year 1993-94.Data set is divided into winter, summer and monsoon season. Double log model is used for estimations. The estimated price elasticities for winter, monsoon and summer is –0.32,–0.39 and –0.16 respectively while income elasticity is 0.689, 0.647 and 0.658 respectively.

In a recent study, Hondroyiannis (2004) estimates residential electricity demand in Greece by using monthly data from 1986–1999. Like some other studies, it also incorporates temperature as an explanatory variable. The results show that in the short run, electricity demand is not affected by price, income and temperature. In the long run, however, income elasticity is greater than one i.e., 1.56, price elasticity is –0.41 and that of temperature is –0.19. Likewise, Holtedahl and Joutz (2004) uses a VAR model to estimate electricity demand for Taiwan. The study reveals that short run and long run income elasticities are 0.23 and 1.04. Similarly the short run price elasticity is –0.15 showing that it is inelastic.

Using the partial flow adjustment approach and simultaneous equation approach Kamerschena, and Porterb (2004), investigates the electricity demand for period 1973-1998 for U.S. Estimates of residential price elasticities vary from –0.85 to –0.94 in 3SLS. However, estimates of price elasticities by partial-adjustment model shows biased results since the problem of endogeneity is not taken into consideration. Narayan and Smyth (2005) uses two models to estimate electricity demand in Australia. In model 1 the natural logs of levels of the variables are taken, whereas in model 2 the natural log of the ratio of the real price of electricity to the real price of natural gas, per capita residential electricity consumption, real per capita income, and temperature are used. In model 1 income and own price elasticities in short run are 0.0121 and –0.263 respectively where as for long run they are 0.323 and –0.541 respectively. In model 2 income elasticities in short run and long run are 0.0415 and 0.408 respectively. The relative price variable, in both short and long run, is significant at 1 percent.

3. THEORETICAL BACKGROUND

The household demand for electricity is different from the commercial demand. In this study, we follow the model used by Filippini (1998). It is based on the household production theory. According to this theory, household purchases goods from the market, which are then combined to produce commodities. The household derives utility from these commodities; hence they appear as arguments in the utility function of the household. In this case, the two goods are electricity and capital equipment. The household can not derive utility from either of these goods independently. Thus he combines these two goods to produce a composite energy commodity. Thus the composite commodity Q is given as.

$$Q = Q(E, K) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where E is the electricity and K is the common stock in the form of electric appliances. The utility function of the household is

$$U = U\,(Q, X; D, G) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where D and G are demographic and geographic characteristics affecting household preferences. X is the composite numeraire good that directly yields utility to the household. The household budget constraint is given by:

$$Y = P_Q \,.\, Q + 1 \,.\, X \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad .. \quad (3)$$

Where Y is the income, P_Q is the price of composite good commodity and P_X is the price of composite numeraire good X.

The household have two stage optimisation decisions. In the first stage it will decrease its cost of producing Q, thus behaving as firm. This can be written as

$$Min\,(\,P_E \,.\, E + P_K \,.\, K) \text{ Subject to } Q = Q(E, K) \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Where P_E and P_K are the prices of electricity and electric appliances. The optimisation will provide cost function:

$$C = C\,(P_E,\; P_K, Q\,) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

The derived input demand functions are obtained by applying Shephard's lemma as shown

$$E = \frac{\partial C\,(P_E,\; P_K\;, Q)}{\partial P_E} = E\,(P_E,\; P_K\;, Q\,) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

$$K = \frac{\partial C\,(P_E,\; P_K, Q)}{\partial P_K} = K\,(P_E,\; P_K, Q) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

In the other stage of the optimisation problem, the household maximise utility

$$Max\; U\,(Q, X; D, G) \text{ Subject to } C\,(P_E, P_K, Q) + X \text{ " } Y \quad \ldots \quad \ldots \quad (8)$$

Formulating lagrangian function:

$$L = U((Q, X; D, G) + \lambda.(Y - C(P_E, P_K, Q) - X)) \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

Demand function for commodities S and X is:

$$Q^* = Q^*\,(P_E,\; P_K, Y; D, G) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

$$X^* = X^*\,(P_E,\; P_K, Y; D, G) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

Using Equations (6), (7) and (10) we obtain the input demand functions given as follow:

$$E = E\,(P_E\;,\; P_K,\; Q^*\;(P_E, P_K, Y; D, G)$$

$$= E\,(P_E\,,\ P_K\,, Y; D, G) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

$$K = K\,(P_E\,,\ P_K\,,\ Q^*\ (P_E\,,\ P_K\,, Y; D, G)$$
$$= K\,(\ P_E\,,\ P_K\,, Y; D, G) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

Equation 12 is our required equation. It shows the dependence of the electricity demand on the price of electricity, prices of appliances, income, demographic and geographic variables. We can expect two types of responses from the consumer. In the short run, for example due to a price change, the consumer will change the rate of utilisation of electricity. In the long run, however, he could change the electric appliances in such a way the less electricity using appliance are used by him. Thus we will estimate both short run and long run elasticities. For this purpose we will use log-linear specification[3].

4. ESTIMATION TECHNIQUE

In the literature on electricity demand, the practice of using the autoregressive distributed lag (ARDL) was very common till late 1980s. However, the finding that the variables used in the estimation of energy demand relationship are non-stationary and are integrated of order one led to use of cointegration methods and ECMs for the estimation of short run and long run energy demand elasticities. The reason for the abandonment of the ARDL model was that, in the presence of non-stationary variables, the standard statistical results in general were not authentic [Bentzen and Engsted (2001)]. However, Sims (1990), and Pesaran and Shin (1999) have shown that the ARDL model is still valid in the presence of I(1) variables if there is unique long relationship among the variables.[4] Since all of the variables in our study are found to be I(1) and there is a unique cointegrating vector, we apply ARDL model in our estimations. A general ARDL (*p*, *q*) model for electricity demand (*ED*) as a function electricity price (*EP*), household income (*HHI*), household size (*HHS*) and their respective lags can be written as

$$ED_t = \alpha_0 + \sum_{i=1}^{p} \lambda_i ED_{t-i} + \sum_{i=0}^{q} \gamma_{1i} EP_{t-i} + \sum_{i=0}^{q} \gamma_{2i} HHI_{t-i} + \sum_{i=0}^{q} \gamma_{3i} HHS_{t-i} + u_i \quad \ldots \quad (14)$$

The short run price, income and household size elasticities, which are γ_1, γ_2, γ_3, can be obtained by applying the OLS technique on Equation (14). The long run elasticities can then be obtained by dividing the sum of current and lagged values of each variable by one minus the sum of lagged values of the dependant variable.[5] One simple criterion, mostly used for the selection of appropriate lag length is Schwarz Bayesian Criterion (SBC). We also follow this criterion in the underlying study. However, at the selected lag length through SBC, we also check for serial correlation and heterosecdasticity.

[3]Due to lack of data we can not estimate Equation 13.

[4]For further simplified details on this issue, readers are encouraged to read Bentzen and Engsted (2001).

[5]For a detailed derivation of Equation (14) and long run elasticities, the readers must consult Bentzen and Engsted (2001).

5. DATA AND VARIABLES CONSTRUCTION

The main objective of this paper is to investigate residential demand for electricity in Pakistan. For this purpose we take price, income and household size as main determinants of electricity demand.[6] The data used for estimation is from 1979 to 2006.[7] This section describes the construction of variable, data and their sources. First we discuss the construction of price index. Data for price of electricity is available in the unit of price per kWh. The problem is that per kWh price differs for different ranges of usage. This left us with various prices of electricity for a year. Taking simple arithmetic mean of these prices is not appropriate because it will give same weight to all the prices. Thus we construct the price index by giving weights to each price by percentage share of consumers using those particular ranges.[8] For example, there is more number of consumers, around forty five percent, whose consumption is between 101-300 units of electricity. So we multiply 0.45 with the price charged for this category. The final price is calculated by taking sum of the products of average shares and prices and this calculated price index is used for estimations since it is a more realistic price index than the one obtained by simple averaging.[9]

Variable of electricity consumption is constructed by using variables of fuel consumption, percentage of electricity consumption out of total fuel consumption and calculated price index. First we obtained monthly electricity consumption out of total fuel consumption. It is then multiplied by 12 to get yearly consumption. The resultant is then divided by the calculated price index in order to get demand for electricity in Kwh. The variable household size is included in model to find the effect of the number of members per household on the demand for electricity. Household income is incorporated in the model to find the effect of change in electricity demanded as a result of change in household income. Data for the last three variables are obtained from Household Income and Expenditure Surveys (various issues).

6. RESULTS AND INTERPRETATIONS

This section explores the results and their interpretation. However, the standard procedure requires testing of unit root in the all the series as well as the number of cointegration vectors. In order to check whether the variables are stationary or not, the Augmented Dickey-Fuller (ADF) unit root test is employed. The results of the ADF test are in given in Table 2 below:

[6]Data of heating degree days is not available so this dummy variable could not be included in the model.

[7]Since data for most variables is not available for all the years, we made use of compound growth rate formula for interpolation to fill the data gaps.

[8]The data for the shares of consumers were available only for Islamabad city and from 1998 to 2006. Taking the assumptions that rich are still rich and as a result the shares have not affected much for different ranges, we extend this trend for previous years included in this study. Also this pattern is assumed for the whole country.

[9]Data for the price of electricity and shares of consumers using different ranges of electricity is obtained from Islamabad Electricity Supply Company, Customer Services, G-7/4 Branch.

Table 2

Results of the Unit Root Test

Variables	Level	First Difference	Conclusion
Electricity	–0.99 (0)	–5.01 (1)***	I(1)
Price	–0.26 (1)	–5.36 (1)***	I(1)
Income	0.54 (0)	–2.82 (0)*	I(1)
Household Size	–1.68 (1)	–3.42 (0)**	I(1)

Note: The regressions include a constant. The numbers in parentheses exhibits the augmentation lags whereas *, **, *** Show significance at 10 percent, 5 percent and 1 percent level of significance respectively.

The results of the ADF test in Table 2 show that all the variables are non-stationary at level at standard levels of significance. However, all these variables are stationary at first difference and hence we can conclude that all the series are integrated of order 1.

Nonetheless, for the application of autoregressive distributed lag (ARDL) model, there should be only one cointegrating relationship among a set of non-stationary variables. Thus it is necessary to check the number of cointegrating vectors among the variables. For this purpose, we use Johansen's VAR approach among the four variables i.e., electricity demand, price, income and household size. Table 3 shows the results of the Johansen test.

Table 3

Johansen Tests for the Number of Cointegrating Relationships[10]

No of CE(s)	Eigenvalue	Trace Statistics	5% Critical Value
None	0.623	50.86	47.85
At Most 1	0.427	25.46	29.79
At Most 2	0.342	10.94	15.49
At Most 3	0.002	0.05	3.84

Note: Although the trace statistics shows a unique long run relationship at 5 percent level of significance. However, this unique relationship is found at 10 percent level of significance using the Max-Eigen Statistics.

Table 3 reveals that the null hypothesis of no cointegrating relationship is rejected. However, the hypothesis of "at most 1" relationship is accepted at 5 percent level of significance. Thus one can conclude that there is a unique long run relationship among the variables selected for estimation in this particular study.

After finding out the order of integration in all the series and a unique long run relationship among the variables, we estimate the Autoregressive Distributed Lag (ARDL) model. The lag length is selected using Schwarz Bayesian Criterion (SBC). The results show a lag length of 3 for dependant variable while 0 for the explanatory variables. These are acceptable results because we are using annual data. With these lag-lengths, we found neither serial correlation nor hetroscedasticity. The estimation results showing the short-run and long-run elasticities along with other relevant statistics including the test results for autocorrelation and hetroscedasticity are given in Table 4.

[10]The Johansen VAR analysis is done using one lag which is chosen using SBC. The analysis used the specification which allows for an intercept term but there is no trend in cointegrating vector.

Table 4

Estimation Results of the ARDL Model

Variables	Values
Constant	–14.34***
	(2.21)
Short Run Price Elasticity	–0.63***
	(0.08)
Short Run Income Elasticity	1.05***
	(0.11)
Short Run Household Size Elasticity	4.70***
	(0.71)
Long Run Price Elasticity	–0.77
Long Run Income Elasticity	1.29
Long Run Household Size Elasticity	5.76
SEE	0.08
Adjusted R^2	0.96
SBC	1.61
LM (4)	6.58
	(0.15)[a]
LMARCH (4)	3.71
	(0.44)[b]

Note: The standard errors of the estimated elasticities are given in the parentheses. The superscript *** shows significance at 1 percent level of significance. LM (4) and LMARCH (4) are the Lagrange multiplier tests for up to fourth order autocorrelation and autoregressive conditional heteroscedasticity respectively, with the superscripts "a" and "b" showing their respective probabilities. The lag order is (3, 0, 0, 0).

Table 4 presents some very interesting results. It shows that all the parameters are highly significant at the standard level of significance and have expected signs both in short run and in long run. We discuss each variable one by one. To start with, in the short run the price elasticity is only –0.63, suggesting that the electricity demand is price inelastic. Although this value increases in absolute term in the long run to –0.77, it still remains below unity. From these results one may conclude that electricity is strictly a necessity both in the short run and long run. The theory regarding price elasticity of electricity demand says that when there is an increase in the price of electricity, the people in response reduces the rate of utilisation in the short run. In the long run, it says, people then change the composition of the stock or electricity appliances in such a way that the demand for electricity further reduces. Hence the long run elasticity is greater than the short run. Although our results do follow this theory regarding the values in the short run and long run, yet this difference is not substantial. One reason may be that, in Pakistan most people do not use electricity for cooking and heating purposes, though they do use for cooling purposes. So when there is a price change, they do not substantially change the stock of electric appliances. One can also attribute this low long run elasticity to the ignorance of people regarding the knowledge about the appliances which utilise low electricity. A third important reason may be the unavailability of appliances using alternative energy sources and if there are such appliances, their performance is not satisfactory comparing to electric appliances. Due to these reasons only some people may reduce electricity demand by substituting only some of the electric appliances resulting in inelastic demand for electricity even in the long run.

The positive sign of the income elasticity of demand indicates that electricity is a normal good. The short run income elasticity is 1.05; almost unity. The long run income elasticity is 1.29. Thus it means that when there is a 1 percent increase in income of the household, there is a 1 percent increase in electricity demand in the short run and more than 1 percent increase in the long run. From this one can conclude that over the long run, increase in income will result in further purchase of electric appliance along with increase in the rate of utilisation. This strengthens the notion that Pakistani society is a consumption oriented society. This may also lead one to conclude that electricity has become an important part of life and people are becoming more dependants on electric appliances.

The third variable is the household size which is highly significant and has expected positive sign. Its short run and long run elasticities are 4.70 and 5.76 respectively. This suggests the electricity demand is highly elastic to household size in both short run and long run. From this, one may conclude that people adjust the rate of utilisation as well as their stock of electric appliances according to their household needs. A larger household size means more members in a household which in turns requires more fans, bulbs, tube lights, air conditioners and air coolers for greater time period. This may lead to the important conclusion that a high population growth rate is also an important factor contributing to the increase in demand for electricity in Pakistan.

7. CONCLUDING REMARKS

Pakistan is currently facing a severe electricity crisis in terms of its short fall. This is due to both reduction in supply and increase in demand for electricity. Our study is concerned with the second part. Some conclusions can be drawn from the above results. First, a low short run and long run price elasticity (inelastic demand), for whatever reasons mentioned above, means that policy of electricity conservation through increase in price alone may not be affective. The government must also provide people with alternative appliances along with creating awareness in the general public about it. Secondly, the government should seriously focus upon the population growth rate in the country. It should formulate such policies that could reduce the population growth rate.

REFERENCES

Anderson, K. P. (1973) Residential Energy Use: An Econometric Analysis. The Rand Corporation (R-1297-NSF).

Bentzen, J. and T. Engsted (2001) A Revival of the Autoregressive Distributed Lag Model in Estimating Energy Demand Relationship. *Energy* 26, 45–55.

Filippini, M. (1999) Swiss Residential Demand for Electricity. *Applied Economics Letters* 6, 533–538.

Filippini, M. (1999) Swiss Residential Demand for Electricity. *Applied Economics Letters* 6, 533–538.

Filippini, M. and S. Pachauri (2002) Elasticity of Electricity Demand in Urban Indian Households. (CEPE, Working Paper No.16).

Fisher, F. M. and C. Kaysen (1962) *A Study in Econometrics: The Demand of Electricity in United States.* Amsterdam: North Holland Publishing Co.

Halvorsen, R. (1975) Residential Demand for Electric Energy. *The Review of Economics and Statistics* 57:1, 12–18.

Holtedahl, P. and F. L. Joutz (2004) Residential Electricity Demand in Taiwan. *Energy Economics* 26, 201–224.

Hondroyiannis, G. (2004) Estimating Residential Demand for Electricity in Greece. *Energy Economics* 26, 319– 334.

Houthakker, H. S. (1951) Some Calculations of Electricity Consumption in Great Britain. *Journal of Royal Statistical Society (A),* 144:111, 351–371.

Houthakker, H. S. and L. D. Taylor (1970) *Consumer Demand in United States.* (2nd ed.) Cambridge: Harvard University Press.

Houthakker, H. S., P. K. Verleger, and D. P. Sheehan (1973) *Dynamic Demand Analysis for Gasoline and Residential Electricity.* Lexington, Mass: Data Resources, In.

Hsiao, C. and D. Mountain (1985) Estimating the Short-Run Income Elasticity of Demand for Electricity by Using Cross-sectional Categorised Data. *Journal of the American Statistical Association* 80:390.

Kamerschen, D. R. and D. V. Porter (2004) The Demand for Residential, Industrial and Total Electricity, 1973–1998). *Energy Economics* 26, 87–100.

Mount, T. D., L. D. Chapman, and T. J. Tyrrell (1973) Electricity Demand in the United States: An Econometric Analysis. Oak Ridge National Laboratory, Oak Ridge,Tenn (ORNL-NSF-49).

Narayan, P. K. and R. Smyth (2005) The Residential Demand for Electricity in Australia: An Application of the Bounds Testing Approach to Cointegration. *Energy Policy* 33, 467–474.

Pakistan, Government of (2008) *Pakistan Economic Survey*. Islamabad: Planning Commission.

Pakistan, Government of (Various Issues) *Household Integrated Economic Survey*. Islamabad: Federal Bureau of Statistics.

Pesaran, M. H. and Y. Shin (1999) An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. *Econometrics and Economic Theory in the Twentieth Century: The Ragnar Frish Centennial Symposium.* Cambridge: Cambridge University Press.

Sims, C. A., J. H. Stock, and M. W. Watson (1990) Inference in Linear Time Series Models with Some Unit Roots. *Econometrica* 58:1, 113.

Wilson, J. W. (1971) Residential Demand for Electricity. *Quarterly Review of Economics and Business* 11:1, 7–22.