Study the Effect of Value-Added of Services Sector on Forecasting of Electricity Demand in Services Sector due to Price Reform

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Abstract

Electrical energy is as one of the important effective factors on economic growth and development. In recent decades, numerous studies in different countries to estimate and forecast electricity demand in different parts of the economy have been made. In this paper, using the method ARDL, estimation and forecasting of electricity demand in the services sector of Iran are determined for the time period from 1983 to 2012. Estimated equations show that the added value of the services sector and a significant positive impact on the demand for electricity in this sector.

The price elasticity for services sector is smaller than 1 due to low electricity prices and subsidized electricity. Hence, electricity prices have little impact on the demand for electricity. The results of the estimate represents a long-term relationship between the variables in the services sector. In this paper, based on amendments to the law on subsidies and estimated values, anticipated electricity demand until the end of the fifth development plan was carried out. The results indicate an increase in power consumption in the services sector.

Resumen

La energía eléctrica es uno de los factores importantes efectivos en el crecimiento económico y el desarrollo. En las últimas décadas, se han realizado numerosos estudios en diferentes países para estimar las previsiones de demanda de energía eléctrica en diferentes partes de la economía. En este trabajo, utilizando el método ARDL, se determinan la estimación y predicción de la demanda de electricidad en el sector servicios de Irán para el período de 1983 a 2012. Las ecuaciones estimadas muestran el valor añadido del sector servicios y un impacto positivo significativo en la demanda de electricidad en este sector.

La elasticidad de los precios para el sector servicios es menor que 1, debido a los bajos precios de la electricidad y la electricidad subvencionada. Por lo tanto, los precios de la electricidad tienen poco impacto en la demanda de electricidad. Los resultados de la estimación, representan una relación a largo plazo entre las variables en el sector de los servicios. En este trabajo, basado en las enmiendas a la ley sobre las subvenciones y los valores estimados, se determinó la demanda de electricidad prevista hasta el final del quinto plan de desarrollo. Los resultados indican un aumento en el consumo de energía en el sector de los servicios .

Keywords: Electricity, value-added, ARDL, Services sector, Price reform

JEL: Q31, E64, L16, C32

1. Introduction

Study of electricity demand and its changes in course of time, in accordance with sub economic sectors and social changes, is one important section in process of planning of optimal development of energy system. Developing of the capacity of electricity production requires long run forecasting and future prognostication of electricity demand. As an industry, electricity has two major features that make it different from other industries as follows:

1. Significant investment for new capacities, transition and distribution.
2. Remarkable required time for making new capacities.

Hence, to identify the behavior structure of sectoral electricity consumption precisely, it is necessary to examine the factors that effect on electricity demand in various sectors such as services, agriculture and manufacturing. In process of analyzing the electricity demand, information about important factors such as value added on consumer behaviors and electricity consumption method in economic sectors should be determined. Knowing of these factors make programmers and policy makers able to have proper performance in its production and consumption.

In this paper, based on theoretical basis, the significant effect of value added of services sector on its electricity consumption by using ARDL[1] approach for period of 1983 to 2012 has been tried to be studied. Finally, we will estimate the electricity demand until 2014. We used *Microrfit* in ARDL approach.

2. Empirical studies review

In recent decades, vast studies have been done for forecasting of electricity demand in various sectors of economy of several countries which contain information of sectors. We try to mention some of them as follow:

Halafi and Eghbali (2005), estimated the household and industrial electricity demand in Khuzestan from 1971 to 2001 by using ARDL approach. Based on theoretical background and empirical studies, household demand function was:

LCRE = F (LCRE(P), LRPRE, LRMCP, LOPI)

Which LCRE represents the electricity consumption of household in Kwh, LCRE(P) is the lag of *p* variable, LRPRE is real average price of electricity in household sector, LRMCP is annual real average cost of household, LOPI is retail price index of kerosene.

Estimated electricity demand function for industry was:

LCIE = F(LCIE(P), LRPIE, LKVAI, LWGPI, LWOPI) (1)

Which LCIE denoted for the electricity consumption of industry in Kwh, LCIE(P) is the lag of p variable, LRPIE is real average price of electricity in household sector , LKVAI is real value added in industrial sector, LWGPI whole sale price index of gasoil and LWOPI is whole sale price index of kerosene.

Results of this study show, first, household and industrial demand functions are stable and equilibrium and secondly, no substitution energies price were accepted in estimated functions. Thirdly, price and income elasticity of electricity reveal that household demand for electricity is inelastic to price and income and industry demand for electricity is inelastic to price and elastic to industry value added in Khuzestan.

Sharma and Balasubramanian (2005) forecasted electricity demand in India in several sectors for period of 1970 to 2005. In this research, estimating electricity demand was studied as an instrument for managing the demand, planning investment in future energy market and price liberalization of fuel. So, he developed appropriate model for electricity demand in different sectors. Electricity demand for different sectors as a liner econometrics model is as follows:

$$LnE_{ti} = a_i + b_i LnA_{ti} + c_i LnL_{ti} + P_i LnP_{ti} + e_{ti} \quad (4)$$

In this model, E_{ti} represent the electricity consumption in sector i, A_{ti} represent the production in each setor, L_{ti} represent consumption in period t-1 and P_{ti} represent the price of electricity in different sectors. Results indicate that electricity demand has increased from 1.52 to 7 percent. Swift increase implies fast economic and electricity consumption growth are because of structural changes in India.

Samadi et al. (2008), estimated a partial adjusted model for electricity demand as follows:

$$LE = 0.197 - 0.078LP + 0.131LY + 0.755LE1 \quad (2)$$

t: (3.11) (-3.13) (2.44) (3.89)

Which E denotes per capita consumption of electricity, P is electricity price, Y is gross domestic production per capita and E1 is per capita consumption. For omitting the serial correlation between residuals, the lag of dependent variable was used in the model. Results show that long run respond to price and income changes was greater than short run response to these changes. Besides, ARIMA model was estimated for forecasting electricity demand. This model imply that per capita electricity consumption increase 4.4 percent annually, which shows the dramatic growth of electricity consumption in Iran.

Bianco et al. (2009), estimated the demand for electricity by using liner regression model to evaluate the effect of economic and population factors on electricity demand for Italy from 1970 to 2007. This model is as follows:

$$Y_t = a + b_1X_1 + b_2X_2 + b_3X_{2,t-1} + b_4Y_{t-1} + e \quad (3)$$

Where Y_t denoted for annually consumption for electricity, X_1 is GDP, X_2 is population in thousand and e is error term.

Results indicate that electricity demand either in household and other types is low elastic to price and elastic to income. The long-run elasticity is greater than short-run elasticity and there is no necessity for interjecting price descriptive variable into the model to estimate electricity consumption in Italy.

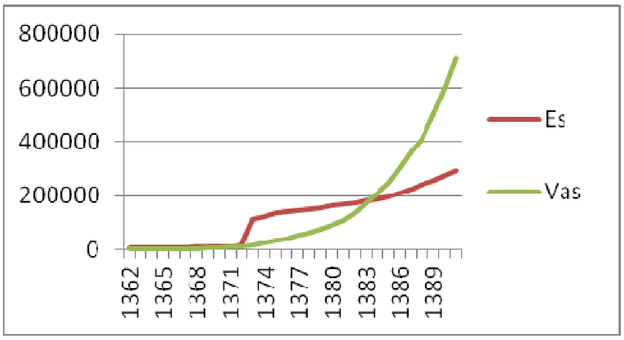
Mohammadi (2013) studied the industrial electricity demand in Iran (based on structural time series approach). Regarding to economic factors and exogenous non-economic factors, he formulated the industrial electricity demand in Iran between 1974 and 2012. The results of estimating the model implies the random nature of the trend variable and shows that non-economic factors have significant effect on forming electricity demand in industrial sector. The upward trend of UEDT reveals that electricity in industrial sector was not used efficiently. Indeed, the role of exogenous factors such as Technology promotion, structural changes, utilizing some efficient and providential standards and government activities affected the electricity consumption in industrial sector.

Lotfalipour et al. (2015), tried to estimate the functions of electricity demand of household and industrial sector by using STSM[1] method and defining and using UEDT[2] in STSM from 1976 to 2011. Results show that Electricity demand is inelastic to price and income in short-run and long-run.

3. Electricity consumption and value-added trend in service sector

Based on classification of ministry of power, main electricity consumption sectors in Iran are: household, industry, services, agriculture and other consumptions. Figure 1 shows the trend of electricity consumption and value-added in services sector where both time series had increasing trend from 1989 and in accordance to first development plan and the relationship between these two variable can clearly be seen in the figure. From the late 70s onwards, value-added kept his increasing trend more sharply than electricity consumption trend.

Figure (1) – electricity consumption and value-added in services sector



Source: Federal bank of Iran, Economic report and Federal Reserve balance of payment, 1983-2012

4. Theoretical basis

Based on microeconomic theory, demand for all kind of energy for production sectors as an input is derived from production function as in equation (5). For instance, production function of a specific firm in a defined time is described as follows:

[1] Structural Time Series Method
[2] Urgent Energy Demand Trend

A firm choses a combination of inputs which has the lowest cost for producing a given level of production. By minimizing firm's cost function and with regarding to the given level of output, demand function for inputs will be found.

Suppose the production function of an individual firm is defined as follows:

$$Q = Q(J, N) \qquad (5)$$

Where N represent the energy consumption which include electricity (E) and substantial energies (S), J represent other production factors. Moreover, we consider that the cost function of firm is:

$$C = P_j J + P_s S + P_e E \qquad (6)$$

Hence, by using Lagrange function, we have:

$$Min L = P_j J + P_s S + P_e E + \mu(\overline{Q} - Q(J, N(E, S)) \qquad (7)$$

$$S.t : C = P_j J + P_s S + P_e E$$

Where P_e is price of energy services, P_s is price of substitution energies, P_j is the price of other inputs and μ is Lagrangian coefficient. After electricity demand optimization we have:

$$X_{ei} = X_{ei}(P_k, P_l, P_m, P_i, Q, S) \qquad (8)$$

In this research, we used ARDL for estimating electricity demand for services sector and examine the relationship between demand of each sector and its value-added. In its basic form, an ARDL regression model looks like this:

$$y_t = \beta_0 + \beta_1 y_{t-1} + ...+ \beta p y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + ... + \alpha_q x_{t-q} + \varepsilon_t \qquad (9)$$

Where ε_t is a random "disturbance" term. The model is "autoregressive", in the sense that y_t is "explained by lagged values of itself. It also has a *distributed lag* component, in the form of successive lags of the *x* explanatory variable. Sometimes, the current value of x_t itself is excluded from the distributed lag part of the model's structure.

The general form of ARDL model is:

$$\phi(L,P)y_t = \sum_{i=1}^{k} b_i(l,q_i)x_{it} + \alpha' W_t + u_t \tag{10}$$

$$\phi(L,P) = 1 - \phi_1 L - \phi_2 L^2 - \ldots - \phi_P L^P \tag{11}$$

$$b_i(L,q_i) = b_{i0} + b_{i1}L + \ldots + b_{iq}L^q \tag{12}$$

Where $LX_t = X_{t-1,}$ L is time delay operation of order, y_t is dependent variable, X_{it} vector of descriptive variables are used in the model, K is the number of descriptive variables used in the model, n_k is the number of optimum lags of each descriptive variable, S is optimum lags of dependent variable, W_t is the vector of certain variables such as intersection.

This model is estimated $(d+1)^{k+1}$ different of ARDL model based on OLS method for $s_=$ 0,1…,d , $n_{t=}$ 0,1,2,…,d and $i_=$ 1,2,…,k. the number of lags is determined by researcher and the whole model is estimated for the period of $t_=$d+1,…,n . then by using Akaike, Schwarz-Bayesian, Hanan Queen or adjusted coefficient of determination, one f the equation will be chosen. Here we used Schwarz-Bayesian for determining optimum lags (Pesaran & shin, 1999).

5. Modeling and estimating

Because of different theoretical basis for consumption and demand function in each economic sector, the demand for electricity in each economic sector is separated. Electricity demand in services sector is defined as follows:

$$E_S = F(VA_S, P_{ES}, P_{GO}, P_G, S_S, POP) \qquad (13)$$

Where

- E_s is electricity demand in services sector(electricity demand in services sector based on amount of sales to customers in Kwh between 1983 and 2012).
- VA_s is value-added in services sector. This descriptive variable represent value-added in services sector. Value-added is the difference between net operational profit after tax and cost of capital, which is based on Federal Reserve report between 1983 and 2012.
- P_{Es} is electricity price in services sector (in Rial per Kwh between 1983 to 2012).
- P_G represent the price of gas as an alternative for electricity(in Rial per M^3 from 1983 to 2012)
- P_{Go} is the price of gas-oil as an important oil production which is used in services sector(in Rial per litter from 1983 to 2012).
- S_s denotes the number of electricity subscribers in services sector(in thousands from 1983 to 2012)
- POP represents the total number of population (from 1983 to 2012).

It needs to be mentioned that in services sector, gas and oil-gas have the most proportion between alternatives' energies for electricity.

First step for estimating the model is to determine the degree of time series integration. One method is Dickey-Fuller test. In this test, test statistic is compared with the critical value of McKinnon table. If the absolute value computed t is greater than absolute value of statistic of McKinnon table, the null hypothesis which implies there is unit root, will be rejected and it means the time series is stationary[3] otherwise time series is not stationary and we should examine the time series by taking differencing.

[3] When a time series variable is stationary that its average, variance and correlation coefficients remain constant over time.

Table 1 shows that the DF statistic of variables is greater than critical value, hence the null hypothesis is rejected and cointegration of variables is first order.

Table (1). Review the variables in the service sector

Variable	Critical value	Test statistic, With first differential, (Significance of 0.05)	Stability status
Ln E_s	-2.9528	-4.2415	Stable with first order
Ln VA_s	-2.9528	-5.2823	Stable with first order
Ln P_s	-2.9528	-5.0207	Stable with first order
LnP_G	-2.9528	-4.7554	Stable with first order
Ln S_s	-2.9528	-4.6541	Stable with first order
Ln P_{fo}	-2.9528	-5.2981	Stable with first order
Ln P_{GO}	-2.9528	-4.3564	Stable with first order

Source: research results

6. Designing a model for electricity demand in services sector

We consider the electricity demand for services sector as follows:

$$E_S = F(VA_S, P_{ES}, P_{GO}, P_G, S_S, POP) \quad (14)$$

Based on theoretical basis and evidences we mentioned earlier, ARDL method is considered for long-run behavior of electricity demand.

(15)

$$LnES = \alpha_0 + \sum_{j=1}^{p} \alpha_j LnES_{t-j} + \sum_{j=0}^{q_1} \beta_{1j} LnVAS_{t-j} + \sum_{j=0}^{q_2} \beta_{2j} LnPS_{t-j} + \sum_{j=0}^{q_5} \beta_{5j} LnSS_{t-j}$$
$$+ \sum_{j=0}^{q_6} \beta_{6j} LnG_{t-j} + \sum_{j=0}^{q_8} \beta_{8j} LnGO_{t-j} + \sum_{j=0}^{q_4} \beta_{4j} LnPOP_{t-j} + \lambda T + \varepsilon_t$$

Where T is trend variable and ε_t is error term. The annual data was used for making the variables real. In the following, we estimated ARDL model based on mentioned variables. For determining the optimum number of lags for each variable in the model, Schwarz-Bayesian criterion was used. The results of this estimation are in the table below:

Table 2. The results of short-term estimation

Variable	Prob	Standard deviation	Coefficient
Ln Es (-1)	0.056	0.17881	-0.39237
Ln VA_S	0.0181	0.81123	4.1602
Ln PE_S	0.181	0.093624	0.13559
Ln POP	0.848	11.5960	-2.2801
Ln Ss	0.075	1.6820	3.3854
Ln GO	0.0	0.22210	-2.1858
Ln G	0.001	0.16742	1.7576
Ln G (-1)	0.001	0.31656	1.5349
C	0.001	49.0520	-251.10
T	-0.004463	0.25301	-1.2388

Source: research results

In this stage, by using the information of above estimation above, long-run cointegration of ARDL variables will be examined. After calculating the statistic, it must be compared with critical value of Banerjee et al. (1992).

$$t = \frac{\sum_{i=1}^{p} \hat{\alpha}_i - 1}{\sum_{i=1}^{p} \delta_{\hat{\alpha}_i}} = \frac{-0.39237 - 1}{0.17881} = \mathbf{-7.78} \tag{16}$$

The calculate t is -7.78 for electricity demand model and the critical value that represented by Banerjee et al. is -4.3 with significant level of 0.95. hence, hull hypothesis is accepted and there is long-run relationship between variables in the model (Tashkini, 2005).

7. Results of estimating the model of electricity demand in services sector

As it has been described in the previous section, estimating model electricity demand has a long-run relationship between its variables. Estimating this relationship is shown in the table 3.

Table 3. Estimation of long-run electricity demand in the services sector

Variable	Coefficient	Prob	Standard deviation
Ln VA_S	2.9878	0.0	0.29007
Ln PE_S	0.097382	0.0213	0.072693
Ln POP	16.7254	0.001	3.5522
Ln S_s	-7146.1	0.282	1.4996
Ln P_{GO}	-2945.2	0.0	0.24573
Ln P_G	3.2945	0.0	0.28732
C	-0.05277	0.001	34.1583
T	0	0.0	0.10677

Source: research result

As in the table above, value-added in services sector has significant and positive effect on electricity demand in long-run. In this relationship, the income elasticity of demand for electricity is equal to 2.9878 which it means if value-added in services sector increased by 1 percent, demand for electricity increases 2.9878 percent.

Besides, price elasticity of demand has significant and positive coefficient and is equal to 0.097382. The cross elasticity of electricity demand to the price of gas is significant and positive and cross elasticity of electricity demand to the price of oil-gas is significant and negative.

8. Forecasting the demand for electricity

To forecast the electricity demand in services sector by using estimated functions and scenario below, the demand for electricity is estimated for 2015. Due to long-run relationship between significant variables, we forecast this demand for services sector. We have these assumptions for forecasting the electricity demand:

1) Growth rate of value-added in each sector is based on the projected rates in 5th development plan of Iran.
2) Growth rate of electricity price and other energies are according to price reform in targeting subsidize legal bill.
3) Growth rate of the number of subscribers is equal to the average growth rate of this variable in the past years.
4) Growth rate of population is 1.3 based on global forecasting.

According to these assumptions, growth rate of value-added in each sector is determined by 4th and 5th development plan of Iran and rate of electricity that was used for forecasting is the price which ministry of power determined based on price reform until 2015[4]. The growth rate of energies were progressed until 2014 based on subsidize targeting reform in Iran.

Table 4. Forecasted values for electricity demand in services sector (in megawatt)

Year	2014	2013
Services sector	325172	309335

Sources: research results

[4] Source: Ministry of power, 2010

This forecasting reveals that consumption will increased in services sector with average rate of 5.3 percent for each period. The main reason for this increase is the rise of alternative energies in services sector and projected production level in 5th development plan.

9. Conclusion

Results of Short-run estimation for income, price and cross elasticity of electricity demand in services sector show that all elasticities are significant in significant level of 5 percent except cross elasticity. Besides, based on estimated data, there is long-run integration in ARDL model which means there is long-run equilibrium relationship between variables of model. The long-run results imply that income elasticity of electricity demand in services sector in significant and positive and is equal 2.9878. Electricity demand is not elastic to its price due to subsid of electricity which cause electricity consumption doesn’t change in respond to its price changes.

Then, growth in electricity consumption in services sector is because of non-price factors. Since the cost of subsidize is high in two last decades, subsidize reform is necessary in Iran. Hence, government should take financial issue to its consideration and improve the structure of subsidizing through social and political instruments. Proper time for reducing subsids, enhance targeting and perfect utilization of savings as a result of subsid cut in the sectors that are more vulnerable, will be useful in price reform. In the other hands, besides price reform and subsids targeting, non-price policies such as reward and punishment for domestic producers to increase the production and electricity efficiency in consumption by utilizing new technologies.

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