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Does price shock in electricity sector correct the consumption pattern in Iran?

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Abstract:

Nowadays role and importance of energy and its effect on economy is inevitable. It has become one of the most significant elements in process of growth as well as development. Thus, considering its importance, energy planning is a pivotal issue in economic planning and it is necessary to know factor influencing energy consumption in order to devise any kind of policy about planning. In order to do this, one needs to construct a theoretical pattern which represents the given economy in mathematical equations. Hence, due to realization of energy prices in Iran and importance of electricity, we have discussed this part of energy consumption. To do so, time series data for the period (1973-2007) has been used. Firstly, logarithm of the series is calculated and then using ADF, stationary of the series has been tested. As the next step, we have performed the Engle-Granger test to check for the spurious regression and finally a long-run relationship between the variables has been estimated. Our results indicate that the electricity is a necessary good and hence, the shocking approach is not an efficient one in order to rectify consumption patterns of electricity.

Keywords: Realization of Prices, Price Elasticity of Electricity, Iranian Economy, Cash Subsidies.

JEL Classification: E21, C01

1-Introduction:

Subsidy has always been a significant feature of Iranian economy. Due to its malfunctions, inefficiencies, and costs, government has recently decided to cut these subsidies on goods and services and with realization of prices, compensate consumers in case. Energy goods amongst them are of most important ones for the government to realize their prices. Considering microeconomic theory, one of the results of this policy is meant to be correction of consumption patterns. It is worth mentioning that due to official statistics, electricity is produced with a cost three times its international price. What is central to this paper is whether or not an abrupt and at-once policy of price realization is capable of creating significant corrections in consumption patterns. This will be answered by referring to the concept of elasticity which is widely used by economists.(Mankiw,2001)

In this paper, we firstly discuss factors affecting electricity consumption. Next, we will represent a model using which one can empirically calculate income and price elasticity for the electricity demand. To do so, we have used the statistics provided by the CBI (Central Bank of Iran) for the period of 1973-2007.

2-Theory:

Modeling is the core of consumer behavior theory. These models usually work with the fact that one individual allocates a budget to a set of goods and are derived from maximization of utility subject to individual consumer's budget constraint. Single function models compared to system approach is easier and more tractable. To derive the demand function within this approach, one needs to obtain the functional form for the demand based on the theory and then estimate a regression based on this functional form.

Empirically speaking, this can be represented using different functions, say, linear, exponential, logarithmic, and semi logarithmic functions. In this paper we have used the single equation to show demand function. Since the first objective of this paper is to calculate elasticity, we have chosen the logarithmic representation of the model. In order to transform electricity demand to a macro level, we have controlled for GDP, electricity price, gas price, and urban as well as rural population of Iran. These variables can be summarized in this set of functions:

$$CE_t = Y_t^{\beta_1} Pe_t^{-\beta_2} Pg_t^{\beta_3} U_t^{\beta_4} R_t^{\beta_5} (1)$$

$$LnCE_t = \beta_1 LnY_t - \beta_2 LnPe_t, + \beta_3 LnPg_t + \beta_4 L\, nU_t + \beta_5 LnR_t + e_t \ldots.. \qquad (2)$$

In which the variables are defined as follows:

Y_t: Gross Domestic Product

Pe_t: Electricity Price

Pg_t: Gas Price (used as a proxy of a substitute to electricity)

U_t: Urban Population

R_t: Rural Population

It needs to be explained that as the government has planned to compensate consumers by paying a fixed amount of money, we have used variables like GDP (as a proxy of income in macro level) and population. (Note 1)

3-Review of Literature:

Silk and Joutz (1997) have analyzed the demand for household electricity in United States. They have used ECM for the period 1049-1993. Their empirical results suggest that income as well as price elasticity is less than one in magnitude both in long-run and short-run.

Holtedahl and Joutz(2004) in their study which was conducted for the case of Taiwan and the period of 1955-1996, have found that income elasticity of electricity demand is equal to 1 in long-run, while relative price elasticity is less than unity.

Hondroyiannis (2004) based on a non-linear model has studied Greece between 1960 and 1998. Results of his paper indicate that long-run elasticity of income is more than one, whilst price elasticity is less than one.

In another paper, Zachariadis and Pashourtidou (2007) have used a VECM model and time series data for the 1960-2004 spans to examine the electricity consumption in household as well as service sections. Their paper suggests that income elasticity is more than 1 in long-run.

Bianco et al. (2009) considering a linear-logarithmic model and based on the Italian data for the period of 1970-2007 have analysed and predicted electricity consumption. They maintain that electricity consumption is affected by GDP and percapita GDP.

Chandran et al. (2010) have released the same paper using Malaysian data for the years between 1971 and 2003. Their model is and ARDL and exhibits that the demand is relatively inelastic.

4-Econometric Methodology and empirical results:

We have used time series analysis methodology. A key question to determine the method of estimation in time series analysis is the order of integration in variables. In this section we have explained the steps to answer this question and furthermore, have reported the estimation method and results. Besides, as any regression analysis and its results need to be tested, we have implemented a number of diagnostic tests to corroborate accuracy of results.

4-1-Unit root test (ADF)

This test has been applied to find orders of integration in our time series. Harris (1995) states this suitable method is comprised of trend and intercept. As the data generation process is unknown, it is better to build our model with the maximum possible number of parameters. This will reduce the risk of rejecting correct null hypothesis and makes our results more reliable and robust. Then our test results are shown in table 1.

Variable	ADF	p-value	Variable	ADF	p-value
LCE	-2.04	0.55	DLCE	-4.10	0.01
LPE	-1.72	0.71	DLPE	-4.47	0.00
LPG	-2.13	0.51	DLPG	-5.13	0.00
LCE(-1)	-1.74	0.70	DLCE(-1)	-6.30	0.00
LPOP	-0.39	0.98	DLPOP	-4.49	0.00
LY	-0.98	0.93	DLY	-3.79	0.02

The best model is the one which holds the standard classical assumptions of regression methodology, has the highest coefficient of determination(R-Squared), and represents statistically significant coefficient for the model. In the first estimation of model using OLS coefficients are not reliable which is originally due to the multicollinearity of variables. Moreover, model and residuals face significant serial correlation which although keeps our estimation results unbiased, makes them inefficient. That is to say, standard deviations and consequently t statistics are not estimated correctly. Furthermore, residuals show heteroscedasticity as well. In order to preclude multicollinearity problem, one can add independent variables which considering the purpose of this paper is possible here. It has been obviated after adding rural and urban populations to make a new series. Since our intention is to find income and price elasticities, this will not cause any inadequacies. We have also added the first lag of dependent variable to the explanatory variables which set residuals free from serial correlation and heteroscedasticity.

Table 2: results of model estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob
LCE(-1)	0.373767	0.064617	5.784385	0.0000
LPE	-0.032022	0.016516	-1.938878	0.0620
LPG	0.060955	0.017363	3.510710	0.0000
LPOP	1.709418	0.196537	8.697684	0.0000
LY	0.252206	0.040492	6.228548	0.0000
C	-15.02951	1.873546	-8.021959	0.0000

R-squared=0.999 Adjusted R-squared=0.999 Durbin-Watson stat=1.418Log likelihood=94.16522Prob(F-statistic)=0.000 F-statistic=14768.76

$$LEC = 0.373 * LEC1 - 0.032 * LPE + 0.060 * LPG + 1.709 * LPOP + 0.252 * LY - 15.029 \quad (3)$$

(5.784385) (-1.938878) (3.510710) (8.697684) (6.228548) (-8.021959)

All coefficients are significant in this model. Coefficient f determination is a good sign of our estimation (R-Squared= 0.999) which verifies that the model has strongly explained variations of dependent variable. Significant coefficient of the first lag of dependent variable is explained with consumption habits. Since this model is originally written in logarithms, the coefficients stand for elasticity of each explanatory variable. In this sense, price elasticity is -0.032 and the cross elasticity of demand for electricity (the coefficient of gas price) is equal to 0.060. Small magnitude of this coefficient shows that regarding different technologies, people cannot substitute these two sources of energy instead there instantly. Income elasticity having a magnitude of 0.252 is not considerable either.

4-2-LM test:

This is a test which is widely used to check for serial correlation in residuals. Regarding that using lags of dependent variable in right hand makes Durbin-Watson test statistic biased towards 2 which rejects serial correlations, we have used h statistic which is written as follows:

$$h - \hat{\rho}\sqrt{\frac{n}{1-n(var(c))}} \cong \left(1-\frac{1}{2}d\right)\sqrt{\frac{n}{1-n\left(var(c)\right)}} \quad (4)$$

Table 3:Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.004032	Probability	0.949752
Obs*R-squared	0.004276	Probability	0.947863

This is called Breusch-Godfrey and represents Obs*R-Squared statistic that has a CHI SQUARE distribution. The null hypothesis for this test is as follows:

Using this statistic, Obs*R-Squared= 3.335530 and the null hypothesis can’t be rejected in 95% probability. Therefore, our model is free from serial correlation.

4-3-Arch Test

This test is applied to the residuals of regression to check if there is heteroscedasticity in residuals and is shown as follows:

Table 4:Auto-regeressive conditional heteroskedasticity Test

F-statistic	1.429609	Probability	0.256344
Obs*R-squared	3.335530	Probability	0.188668

Here Obs*R-Squared= 0.004276 and F-Statistic=0.004032 which doesn't reject the null hypothesis with 95% probability and hence, our residuals are free from heteroscedasticity.

4-4-Recursive estimation:

These tests are comprised of recursive residuals, CUSUM, Q-CUSUM and in all these tests if terms fall out of two critical lines it shows that the model is structurally unstable.

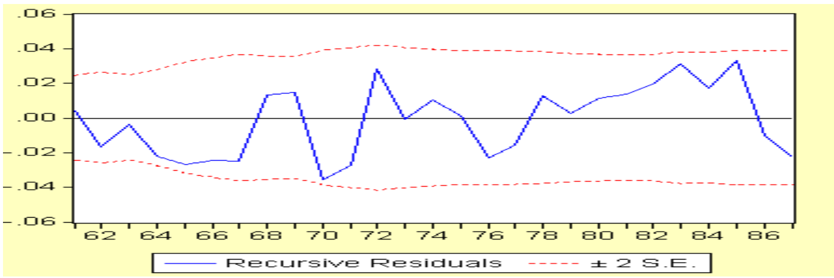

Figure 1.recursive residuals

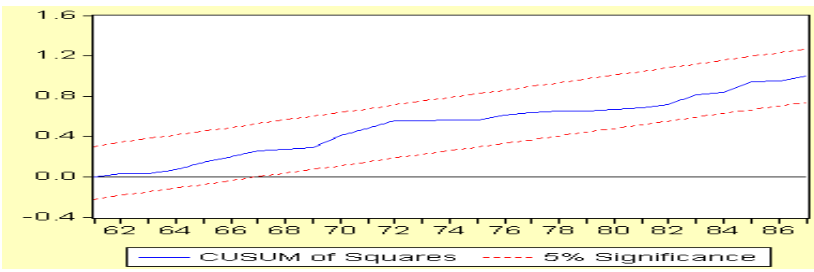

Figure 2.Q-CUSUM

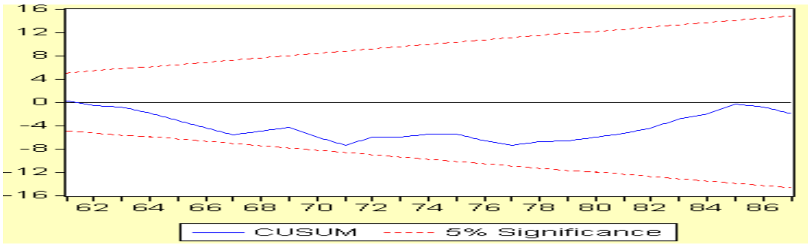

Figure 3.CUSUM

Considering diagnostic tests that we have applied to our residuals, it is now clear that our model is free from serial correlation and heteroscedasticity. However, one other problem that any time series model may encounter is the problem of spurious regression.

4-5-Cointegration test:

Here we have used Engle&Granger (1987) Methodology which states that our variables are cointegrated and one can estimate this model using OLS and not encounter the problem the spurious regression problem.

In this case, H_0 is accepted and is regarded correct

Table 5:Engle granger test

Dependent Variable	Independent Variables						آt-Statistic	Prob
LCE	LPE	LCE(-1)	LY	LPOP	LU		4.02	0.00

Final outcomes of model estimation elucidate that the price elasticity is less than one which depicts electricity as a necessary good. On the other hand, since consumption of electricity is strictly dependent on consumption habits (lagged dependent variable) and not having a close substitute, it can be concluded that shocking approach in order to increase prices will not be of a considerable effect of consumption patterns.

Conclusion:

In order to assess the effects of any cash subsidy policy and or price realization policy, it is necessary to understand the consumer behavior in reaction to policies. Hence, as put forward here, it is obvious that shocking approach will not be effective to correct consumption patterns. This has been confirmed by considering the fact that electricity consumption is strictly dependent on consumption in previous periods (consumption habits). This is in line with the second hypothesis of Duesenberry which states that consumption in current period depends on the consumption on previous periods. In addition, cross elasticity of electricity demand which shows sensitivity of electricity to changes in gas price is trivial. It can be justified by the fact that different technologies are used in consumption of these two major energy goods and as a result, consumers cannot substitute electricity with gas instantly. Last but not least, price elasticity of demand which is less than unity indicates that electricity is a necessary good and thus reactions to the price change will not be considerable.

Note 1.This should be mentioned that the cash subsidy is paid to all Iranian citizens.

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