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Investigation of Energy Consumption, Energy Price and Income in Iran in the Long-Term

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Abstract

Economic activities in the present world has influenced by energy consumption and increasing in its effectiveness. Generally energy is providing from the exhaustible resources now, thus saving is important in order to conservation. However, identifying factors affecting energy consumption in the short-term and long-term is much important to achieve this goal. In present study we examine the relationship between energy consumption and its price and household income over the period 1971-2008 in Iran. We applied the Johanson-Juselius convergence method to check the possible convergence. Present results indicate positive relationship between household income and energy consumption on one hand and negative relationship between energy price and its consumption on other hand in long-term. And because of energy demand sensitivity to price, government is able to prevent non-optimum using with some policies such as energy taxes or increasing in energy price by eliminating of subsidies.

Keywords: Energy demand; Energy price total; Household income; The Johanson-Juselius convergence approach; Exhaustible resources

JEL Classification: E52; E58

Introduction

Analysis of energy demand has increased dramatically for nations of the early 1980s. The first factor was causes this analysis begins, was the concern about energy supply when the oil price shock in 1973 and 1979 occurred. The next factor was concern about climate change, which was conducted on studies about energy demand. Initial work on energy analysis was done in determining the sensitivity of income and energy prices, as significant and effective predictions and political simulations through it was done. Typically these studies were done about long-term and short-term effects of energy prices and GDP (or other variables of total income) on total consumption of one or more kind of fuel in private sector or countries economy. Atkinson and Manning conducted a study on the sensitivity of price and income for developed countries. The sensitivity analysis was done to the year (2006) for developed countries; recently similar analysis is done for developing countries too. In general, long-term estimate of income's sensitivity is generally close to or slightly greater than one and the price sensitivity in the range -1 to -2 is the variable, while the value for the price and income sensitivity is expressed in short term almost is equal to half the values are expressed in long-term mode [1].

As seen in the literature of energy economy, the existence of unit root in economic time series variables explicitly or implicitly is refers to the removal of ARDL model as a framework to estimate the relationship of energy demand. Instead, convergence and error correction of vector technique be used for calculating the non-static variables and determine the economy variables. For example Bentzen [2] found that the energy consumption and real income and energy prices for the Britain and Denmark countries while they are converging are non-static. Finally, they began to estimate the short-term and long-term relationship of the energy demand's sensitivity.

So scholars should be careful in applying of their ARDL model for the non-static variables, because when the variables are not converge, regression can be established between these variables is pseudo regression. Even the variables are converging too, standard statistical inferences such as t and F are not established about them [2]. An interesting point that exists about the vector error correction model is; this model includes only variables that these variables have been converted to a static mode. Therefore with using this property, Standard statistical inference can be applied in the asymptotic state for the null hypothesis of these variables. For example, some times for analysis of long-term and short-term sensitivity, hypothesis tests using standard statistical method for non-static variables are still preserved its statistical value. Presence of unique convergent long-term relationship between variables for preserving these results is necessary.

Theory

Energy carriers are demanded as the marginal products by consumers and as the production inputs by the economic firms. Determination of demand measure for that part of energy carriers which are used marginal products is done according to the theory of consumer behavior and the utility maximization based on the consumer's budget constraint. With forming the first and second condition and assuming that consumer utility function is strictly quasi concave, the demand for energy carriers like demand for other consumption goods will be a function of prices and incomes n-dimensional vector.

So the energy consumption that here include different carriers such as oil, gas, coal and electricity is itself inverse function of the level of energy carriers prices. In other words, increasing energy prices causes that reduced energy consumption. Determining the demand's amount for sector of energy carriers that uses as production inputs in economic firms and in various sectors of industry, transport, agriculture and trade, based on firms theory can be evaluated and analyze. Manufacturing firms may seek to maximize production given a certain amount of cost

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or minimizing the cost given a certain amount production or maybe they are looking profit maximization. The results of the first and second order conditions indicate that in each of the three modes firm's demand for energy input depends on the price of desired carrier and other input prices, product price and production quantity. So the most important economic factors affecting energy demand can be considered price variable and a variable of activity like real national income or real GDP.

Conducted studies

Anderson has reviewed the function of energy demand in both domestic and industrial sectors over the period 1958-1963 in America. The results of his study shows that the electrical energy is substitute with Coke and complementary with Oil and coal, another result of this research shows that electrical energy demand is very sensitive to price in America.

Honkinson and Rhys investigated the determinant factors of the electrical energy demand in industry of England during the period 1955-1980. Results gained from this research shows that some industries to others have more electrical energy consumption. Bentzen and Engsted have estimated the energy demand by using the ARDL and Johansen methods for Denmark during the years 1960-1996. The results show that there is a long-term relationship between energy demand and price and income and this long-term relationship shows the sensitivity of the Denmark economy to energy price [3-6].

Theodoros and Nicoletta looked at the empirical analysis of electricity consumption using Johansen and instantaneous reaction function methods for both short-term and long-term during 1960-2004. The results suggest the existence of long-term relationship between income, price and energy consumption but the energy function can be affected by degree volatility of weather in short term. Ziramba [5] studied the domestic demand for electricity in South Africa. Result showed that income was the main determinant variable of electricity demand in the long term while the demand was insensitive to the price of electricity.

Model and data introduction

In this study, three variables is used to obtain the energy demand function that these are; total energy consumption and total energy prices and GDP that is considered as a proxy for individuals income. Data source is the energy balance sheet and the central bank's data over the period 1971-2008 in Iran. In this case study all the variables are logarithmic. E is considered as the logarithm of energy consumption, PE is the logarithm of energy prices that reflect the real price of energy and it is adjusted to the implicit price index, Y is the GDP log, all the variables mentioned above are used as annual. Most studies are used the following models to estimate the energy demand, so we follow the same model too:

$$E=a_0+a_1 PE+a_2 Y+\varepsilon_\tau \quad (1)$$

Methodology

In this study the Johansen-Juselius convergence method is used to estimate long-term relationship between energy variables and national income [7,8]. Then the vector error correction model will be estimate. In this step, it is necessary to investigate stationary degree of variables before determining the convergence relationship between model variables. If the stationary degree of model variables is the combination of I(1) and I(0), we are able to use these method for investigation the long-term equilibrium relationship between variables1. In the next step, the optimal order of VAR model and the presence or absence of long-term relationship between the variables must be determine using statistics of affect matrix test and eigenvalues maximum [9,10]. ADF results for variables are presented in Table 1.

According to the results in Table 1, it can be state that all variables on 5% significant level with first difference have gone stationary. In next step, the optimal order of VAR model is determined based on criteria to determine the optimal lag. The results are shown in Table 2.

Based on the results in Table 2, it can be state that the optimal lag of VAR model due to the Schwartz- Bayesian's criterion of lag determinant is equaled 2. Next, using the test statistics of effect matrix and maximum of eigenvalue, we review existence or lack of convergence between the model variables [11-13]. Results are presented in Tables 3 and 4.

According to the results of both tests, just there is a convergence vector. Finally the long-term equilibrium relationship between the variables is estimated as follows (Table 5).

According to the long-term equilibrium relationship between the variables, in next step the error correction model of convergence relationship is estimated as compatible with economic theories. Results are presented in Table 6.

Given above table, the coefficient of error correction is equal -0.07, this indicates that the error of each period is reduced with 7% rate to the former period, and dependent variable will move towards the long-term equilibrium value.

Statistics of ADF test		Variable
Making first difference with intercept	In level and with intercept and trend	
-0.0357143	-0.0652174	E
-0.0740741	-0.0121951	PE
-0.0326087	0	Y
-0.0206186	-0.0545455	The critical values

Source: Research findings.

Table 1: ADF test results.

Number of lag	The Schwartz – Bayesian statistics (SBC)
3	-0.084507
2	-7/31
1	-0.2333333
0	-0.1

Source: Research findings.

Table 2: Determinant results of the optimal order of VAR model.

Probability value at 95%	Critical value at 95%	Test statistic's value	Alternative hypothesis	null hypothesis
0/02	25/82	28/47	r =1	r =0
0/14	19/38	15/96	r =2	r =1

Source: Research findings.

Table 3: The maximum eigenvalue test (λ_{max}).

Probability value at 95%	Critical value at 95%	Test statistic's value	Alternative hypothesis	Null hypothesis
0/01	42/91	49/15	r^3=1	r=0
0/19	25/87	20/68	r^3=2	r=1

Source: Research findings.

Table 4: The effect matrix test (λ_{trace}).

t-student statistic value	Standard deviation	Coefficient	Variable name
------	------	1	E
2/07	0/13	-0/27	PE
3/20	0/49	1/57	Y
2	0/01	0/02	T

Source: Research findings.

Table 5: Estimation of long-term relationship between variables (convergence).

Error Correction	D(LE)	D(LPE)	D(LY)
Coint Eq1	-0.079416	0.024479	0.03922
	-0.02807	-0.05336	-0.03857
	(-2.82904)	(0.45877)	(1.01693)
D(LE(-1))	-0.316804	-0.142261	-0.058889
	-0.23486	-0.44641	-0.32266
	(-1.34893)	(-031868)	(-0.18251)
D(LPE(-1))	0.021352	0.650163	-0.039435
	-0.07897	-0.15011	-0.1085
	(0.27037)	(4.33120)	(-0.36346)
D(LY(-1))	0.479306	0.09296	0.45501
	-0.16143	-0.30684	-0.22178
	(2.96916)	(0.30296)	(2.06736)
C	0.0724	0.048519	0.02401
	-0.01874	-0.03562	-0.02575
	(3.86321)	(1.36202)	(0.93252)
R-squared	0.387735	0.511372	0.22038
Adj. r-squared	0.308733	0.448323	0.119783
Sum sq. resids	0.066758	0.241196	0.126007
S.E equation	0.046406	0.088207	0.063755
F-statistic	4.907914	80110729	2.190735
Log likelihood	62.1418	39.02015	50.70708
Akaike A/C	-3.174544	-1.890008	-2.539282
Schwarz SC	-2.954611	-1670075	-2.319349
Mean dependent	0.069129	0.11993	0.031266
S.D. dependent	0.055815	0.118758	0.067955

Source: Research findings.

Table 6: The error correction model.

Conclusions and Recommendations

Due to the important role of energy in economic growth and development, types of energy demand is one of the interesting issues at academic and economic circles of Iran and over the world. Hence, the literature of energy demand has been growing and evolutionary trend in recent decades. In the present study we have investigated the relationship between the energy consumption and its price and household income [14]. The convergence method of Johansen has been used for finding the convergence during 1971-2008 for Iran. Present results indicate the positive relationship between household income and energy consumption on one hand and negative relationship between energy price and its consumption on other hand. Results of the model about the relationship between the energy consumption and energy price shows that people are sensitive to energy price and by changing this variable we can reduce non-optimal consumption and prevent its loss [15]. The main findings of this study showed that the sensitivity of income to total energy demand equal to 0.4. It shows that the economic growth through an increase in the value of this ratio will increase and also shows the reaction of energy consumption to prices that the government can establish a tax on energy and achieve to its goal which is keeping the exhaustible recourses [16].

Note: In this study, given that sample size is less than 100, Schwartz-Bayesian criterion is used to determine the model optimal lag.

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