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On The Relationship between Energy Consumption and Real GDP in Iran: An Application of VEC Model

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Abstract

This paper examines the causal relationship between energy use and real GDP for the period 1967-2002 in Iran. The results of Phillips- Perron test indicate that the real GDP and the four categories of energy , i.e. coal, oil, gas, and hydroelectric energy are integrated of order one. Besides, the Johansen – Juselius maximum likelihood co- integration tests imply the existence of Granger causality. The VEC models that have been estimated to test the direction of Granger causality support a unidirectional causality from GDP to energy use in short run.

Keywords: Energy consumption, Economic growth, Granger causality, VEC model.

1- Introduction

The oil shock in 1973 taught economists that similar to other live phenomena, economy needs energy in order to live and grow.

In theoretical aspect, in the one hand, energy has been considered as an input in the production function, hence, production being a function of energy. On the other hand, energy is dependent upon production when viewed as a demand for the input function.

During the last two decades, the causal relationship between energy consumption and GDP has been a well-studied lie area in economics.

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For the first time Kraft and Kraft (1978), using USA annual data for the period of 1947-1974, showed the unidirectional causality from GNP to energy consumption. Then, such research such that performed by Akarca and Long (1980) challenged the causal relationship. Furthermore »The neutrality of energy consumption« has been added to the literature of energy economics. Yu and Choi (1985) found evidence of neutrality of energy consumption[1] In fact, since the 1980's the direction of caution remind debatable assue.

This paper examines empirically the relationship between primary energy use and real gross domestic product in Iran.

The paper is organized as follows: section 2 describes the methodology. In section 3 the empirical evidence is presented. Finally, section 4 concludes the paper.

2- Methodology

In this paper, the study has been carried out using annual data for the period 1346-1381 in Iran. The empirical study analyzes total, oil, gas and hydroelectric energy consumption distinctly.

On the basis of Stock and Watson's (1989) findings, the traditional Granger causality tests (1969) are sensitive to the stationary of the time series. Hence, co integration test has been used especially in recent studies.[2]

The present paper utilizes Johansen maximum likelihood procedure (1990) for co integration test using maximum eigenvalue statistic. Hence, Schwarz Bayesian Criterion (SBC) is employed to determine the lag length. However, in the first step, Phillips – Perron (1998) unit root test is used to verify the degree of integration. If the presence of co integration is confirmed by Johansen test, the vector error correction (VEC) model can be used to show the direction of causality relationship. According to Engle and Granger (1987), the VEC model will be:

$$\Delta Y_t = a_{21}(l)\ \Delta Y_{t-1} + a_{22}(l)\ \Delta X_{t-1} + \lambda_y ECT_{t-1} + \varepsilon_{2t} \qquad (1)$$

1- For more information, see: Errol and Yu (1987) and Yu and Jin (1992).

2- For example see: Masih and Masi (1996, 1997), Glasure and Lee (1997), Hondroyiannis and Lolos and Papapetrou (2002), Soytas and Sari (2002).

$$\Delta X_{t=}\ a_{11}(l)\ \Delta Y_{t-1} + a_{12}(l)\ \Delta X_{t-1} + \lambda_x\ ECT_{t-1} + \varepsilon_{1t} \qquad (2)$$

Where Y_t, X_t and ε are, receptivity, real GDP, energy consumption and error term. Also, $\Delta, (l)$ and ECT are difference operator, polynomials in the lag operator "L" and the coefficient of the lagged error correction term. Similarly, λ shows the deviation of the dependent variable form the long run equilibrium. The non-significance of explanatory variable coefficients (a_{11} and a_{22}) is referred to as a short run non- causality. In this case, if no causality in either direction is found, "the neutrality hypothesis" will be supported.[1]

In fact, the absence of long run causality is found from the non-significance ECT coefficients. In this case, the dependent variable is weakly exogenous. Thus, if the coefficients of both the explanatory and ECT variables are non-significant, we will find the strong exogeneity of the dependent variable. Considering the distinction of energy consumption, the above steps are taken for four VEC tests:

real GDP and total energy consumption

real GDP and oil energy consumption

real GDP and gas energy consumption

real GDP and hydroelectric energy consumption

The energy consumptions and real GDP time series data (1346-1381) were obtained from Energy Balance Sheet and Iran's Statistical Yearbook published by Energy Ministry and Planning & Budget Organization respectively.

The choice of the research period was constrained by the availabity of Iran's energy consumption data. Following Hondroyiannis, Lolos and Papapetrou (2002) and Soytas and Sari (2002) the variables are defined in logs:

LGDPR: the log of real GDP

LTEC: the log of total energy consumption

LTOC: the log of total oil energy consumption

LTGC: the log of total gas energy consumption

LTEL: the log of total hydroelectric energy consumption

All of the econometric computations carry out using Eviews software.

1- For more information see: Asafu – Adjuye (2000).

The results of the Philips – Perron unit root test for levels and first difference are shown in Table 1. As the table shows, all variables are non-stationary in levels and stationary in first difference. Thus, they integrated of order 1 (I(1)).

Table 1: Results of Phillips-Perron unit Root Test.

variables	levels	First difference
LGDPR	-2.63	-3.32**
LTEC	-2.23	-4.65*
LTOC	-2.23	-4.65*
LTGC	-3.1	-5.55*
LTEL	-2.78	-4.71*

Source: Author calculations.
* = Significant at 1 percent.
** = Significant at 5 percent.

Table 2 shows the co integration test results. The table shows that the value of the calculated test statistics are greater than the critical values which denotes the rejection of the hypothesis of non-co integration as well as long-run neutrality hypothesis.

The results of VEC model estimation have been shown in Table 3 for the causality relationship between real GDP (economic growth) and each energy consumption separately. It can be seen that none of the error correction coefficients are significant in energy consumption equations (except for hydroelectric energy consumption). In fact, these variables are weak exogenous in the long run and change in them does not respond to deviation in long-run equilibrium in period t-1. Also, indicate that the 14.81% of short-run hydroelectric fluctuations will be adjusted in the long run. Due to the significance of error correction coefficients in real GDP equations, a deviation in real GDP will be adjusted to equilibrium value in the long-run.

Considering the lagged explanatory variables T-statistics, it can be seen that in the short-run there is unidirectional Granger causality running from real GDP to energy consumption except for gas energy consumption. The equations reveal that there is no causality relationship between gas energy consumption and real GDP.

Table 2: Johansen Co-integration Test Results

series	Likelihood ratio
LGDPR , LTEC	25.11
LGDPR , LTOC	25.11
LGDPR , LTGC	23.19
LGDPR , LTEL	25.11

Source: Author calculations.

• The critical value for 1 percent and 5 percent are 24.6 and 12.92 respectively.

Table 3: VEC Model Results

	D(LGDPR)	D(LTEC)	D(LGDPR)	D(LTOC)	D(LGDPR)	D(LTGC)	D(LGDPR)	D(LTEL)
COINT Eq	-0.22 (-2.51)	-0.03 (-0.36)	-0.22 (-2.51)	-0.03 (-0.36)	-0.32 (-3.46)	-1.1 (-1.64)	-0.15 (-2.27)	-0.15 (-2.93)
D(LGDP(-1))	0.55 (3.12)	0.45 (2.41)	0.55 (3.12)	0.45 (2.41)	0.41 (3.06)	0.9 (0.9)	0.41 (2.4)	1.26 (2.01)
D(LTEC(-1))	-0.05 (-0.25)	-0.03 (-0.16)	-	-	-	-	-	-
D(LTOC(-1))	-	-	-0.05 (-0.25)	-0.03 (-0.16)	-	-	-	-
D(LTGC(-1))	-	-	-	-	0.02 (0.5)	-0.2 (-0.9)	-	-
D(LTEL(-1))	-	-	-	-	-	-	0.1 (0.39)	-0.02 (-0.1)
C	0.02 (1.19)	0.07 (3.81)	0.02 (1.19)	0.07 (3.81)	0.02 (2.07)	0.18 (2.16)	0.01 (0.46)	0.1 (5.04)

Source: Author calculations.
- Values in parentheses are T statistics.

4- Conclusion

During recent years, extensive investigations have been carried out to test the casual relationship between energy consumption and economic growth. As a case study for Iran, in this paper the causal relationship between real GDP and various energy consumption has been investigated using VEC model. First, the Phillips-Perron unit root tests were administered. The obtained results showed the real GDP and four categories of energy consumption series, including total, oil, gas and hydroelectric, appear to non-stationary in levels but stationary in first difference. Second, the Johansen co integration tests indicated the existence

of Granger causality. Then, four VEC model were estimated in order to determine the direction of causality relationship. The findings suggest that (except for gas) there is a significant of unidirectional Granger causality running from real GDP to consumption. Thus, the increase of energy demand may be caused by energy intensity than economic growth .Considering the effect of economic growth on energy consumption, in order to decrease the pressure on energy resources, improving the productivity and efficiency of energy use are necessity.

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