Revisiting Energy-GDP Nexus for the Selected Countries of the Middle East Region

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Abstract

This paper investigates the relationship between total energy consumption and GDP in six countries of the Middle East , including Iran,Pakistan,Saudi Arabia,Oman,Bahrain and the United Arab Emirates. The data are annual and spanning the period 1980-2012.We employed Hsiao's (1981) methodology to examine causality relation between total energy consumption and GDP.The empirical findings show a unidirectional causality relation between total energy consumption and GDP for Iran running from energy to GDP,and supports the growth hypothesis for Iran. For Saudi Arabia there is a unidirectional causality running from GDP to total energy consumption. Therefore we can accept conservation hypothesis about Saudi Arabia.There is bidirectional causality relation for other countries which support the feedback hypothesis about them.

Keywords: Energy consumption, GDP, Middle East, Causality relation

1- Introduction

Middle East region is well-known to export energy (oil and gas) in the world. Middle East counties have more than 800 billion barrels of proved reserves of oil. (Saudi Arabia(265.9), Iran(157), Kuwait(101.5), Qatar(25), Oman(5.5), Bahrain (0.125), UAE(97.8))[1]. Moreover this region has more than 2823 trillion cubic feet of gas (Iran and Qatar have largest gas proved reserves with about 1187 and 890 trillion cubic feet respectively)[1]. Although these figures can be different because of different statistical sources and also exploration of new oil fields in the future. Many of these states are oil-

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dependent economy and their economies are vulnerable to the energy shocks and oil price. In this region hormuz strait is one of the most important energy transit canals in the world. These issues have made many international political, cultural, environmental, social and economical challenges (such as Dutch disease) for this region. The main goal of this paper is to examine total energy consumption-GDP relation for six selected countries of the Middle East. This issue is an ongoing debate in the energy economics literature. In this context we confront with four different hypotheses: neutrality hypothesis, feedback hypothesis, growth hypothesis and conservation hypothesis.

Neutrality hypothesis indicates no causality between energy consumption and economic growth in any directions. Conservation hypothesis indicates a unidirectional causality running from economic growth to energy consumption. Growth hypothesis indicates a unidirectional causality running from energy consumption to economic growth. Feedback hypothesis indicates a bidirectional causality between economic growth and energy consumption. Each hypothesis has its own importance in policy implications (Wei Zhang and Shuyun Yang, 2013).

Contribution of this paper to the past literature is employing Hsiao's (1981) methodology. The remainder of this paper is organized as follows. In section2 we review some of the past studies and their results.In section3 we introduce the data and methodology. In section4 we obtain empirical results and analyze them and in the last section we add up the results.

2- Review of literature
In this section we review some of the past studies about energy consumption-GDP relation.The results of many of these studies are not consistent each other,because of different period of study and different approaches.One of the main studies about this issue goes back to the Kraft and Kraft(1978) study for the USA economy. They found evidence in favour of causality running from GNP to energy consumption in the United States, using data for the period 1947-1974. Masih and Masih (1996) found cointegration between energy and GDP in India, Pakistan and Indonesia, but no cointegration in Malaysia, Singapore or the Philippines. By using a vector error correction model (VECM), they showed that energy consumption is causal to income in India, income is causal to energy consumption in Indonesia, and bidirectional causality exists in Pakistan. This study applied an ordinary VAR model for the rest of the three non-cointegrated countries (Malaysia, Singapore and the Philippines) but did not find any causality.

Cheng (1995) used a bivariate analysis and found no causality between energy use and GNP in the USA in either direction. Using a multivariate analysis, he also found no causal relationship between energy use and GNP. Asafu-Adjaye (2000) tested the causal relationship between energy use and income in four Asian countries using the cointegration and error-correction analysis. He found that causality ran from energy to income in India and Indonesia, and also showed a bi-directional causality in Thailand and the Philippines.

Soytas and Sari (2003) studied causality between energy consumption and GDP for the G-7 countries and for the top 10 emerging economies excluding China. They found bi-directional causality for Argentina, unidirectional causality from GDP to energy consumption in Italy and Korea, and unidirectional causality from energy consumption to GDP in Turkey, France, Germany and Japan. Mehrara (2007) examined the causal relationship between the per capita energy consumption (PCEC) and the per capita GDP in a panel of 11 oil-exporting countries (Iran, Kuwait, Saudi Arabia, United Arab Emirates, Bahrain, Oman, Algeria, Nigeria, Mexico, Venezuela and Ecuador) by using panel unit root tests and panel cointegration analysis. The results showed a unidirectional strong causality from economic growth to energy consumption for the oil-exporting countries. Mahmoud A. Al-Iriani (2006) investigated the causality relationship between GDP and energy consumption in the six countries of the Gulf Cooperation Council (GCC). Empirical results indicate a unidirectional causality running from GDP to energy consumption. Evidence shows no support for the hypothesis that energy consumption is the source of GDP growth in the GCC countries. Reynolds and Kolodziej (2008)examined the relationship between GDP and production of some energy sources for the former Soviet Union by Granger causality and found unidirectional causality from energy consumption to GDP and unidirectional causality from GDP to coal production and natural gas.Behmiri and Manso(2012) analyzed the relationship between oil consumption and economic growth for OECD countries and found that there is bi-directional causality between them.

3- Data and Methodology

Many papers have been published about energy consumption-GDP linkage.Base on the data and goal of research, researchers have used different approaches. For study of group countries researchers used panel cointegration techniques (Narayan et al, 2010; Lee, 2005).In recent decade many researchers employed Toda and Yamamoto(1995) methodology

because of nonstationary variables (see Hondroyianais et al, 2002 ; Fatai et al, 2002; Wolde-Rufael, 2004; Lee, 2006),and many of them employed vector error correction model(see Mahmoud A. Al-Iriani , 2006; Asafu-Adjaye, 2000; Lise and Montfort, 2007; Yoo, 2005; Glasure, 2002).In this paper we examine the relationship of total energy consumption(TEC hereafter) and gross domestic product (Y hereafter). The data were obtained from world development indicators 2013, published by the world bank. Total energy consumption is in quadrillion Btu and gross domestic price is in constant price and local currency. All data are annual and spanning the period 1980-2012. All variables used are in natural logharitm. In this step we must identify integration order of variables. To this end we employ KPSS unit root test which proposed by Kwiatkowski, Phillips, Schmidt and Shin (1990).Table1 shows the results.

Table1: KPSS Unit Root Test Results

Variable	LM-stat.	(C.V)[**] 5%	(C.V) 1%
IRAN			
LnY(C,T)[*]	0.1562	0.146	0.216
LnTEC (C,T)	0.074	0.146	0.216
UNITED ARAB EMIRATES			
LnY(C,T)	0.138	0.146	0.216
LnTEC(C,T)	0.147	0.146	0.216
BAHRAIN			
LnY(C,T)	0.117	0.146	0.216
LnTEC(C,T)	0.09	0.146	0.216
SAUDI ARABIA			
LnY(C,T)	0.172	0.146	0.216
LnTEC(C,T)	0.086	0.146	0.216
OMAN			
LnY(C,T)	0.177	0.146	0.216
LnTEC(C,T)	0.100	0.146	0.216
PAKISTAN			
LnY(C,T)	0.155	0.146	0.216
LnTEC(C,T)	0.185	0.146	0.216

*C and T indicate intercept and time trend respectively.
**C.V indicates critical value.

According to the results all variables are stationary at 5% and 1% significance level, therefore we can use conventional granger causality test. We included a constant and a time trend for variables because   time trend and constant were statistically significance. Because all the variables are in levels, the results can provide the information about the long-run causal relationship among variables in the model. Thanks to the stationary variables we can use conventional granger causality test. The variable X is said not to granger cause the variable Y if all the coefficients of lagged X in are not significantly different from zero (Equation 1), because it implies that the history of X doesn't improve the prediction of Y. And conversely the variable Y is said not to granger cause the variable X if all the coefficients of lagged Y in are not significantly different from zero (Equation 2).

$$Y_t = \sum_{j=1}^{m} \beta_j \, Y_{t-j} + \sum_{i=1}^{n} \alpha_i \, X_{t-i} + \varepsilon_t \tag{1}$$

$$X_t = \sum_{i=1}^{n} \alpha_i \, X_{t-i} + \sum_{j=1}^{m} \beta_j Y_{t-j} + v_t \tag{2}$$

One of the most important issues in this approach is to discern appropriate number of lags, because this approach is very sensitive to the number of lags. For this reason we use Hsiao's (1981) methodology, which combines the Akaike (1969) final prediction error (FPE) criterion with granger's causality test to guide the selection of the appropriate lag specifications. This method consists from two steps, in the first step we run a equation for a variable with it's past lags. In this step we discern appropriate number of lags based on minimum final prediction error (FPE).For example in Equation 4 we identify optimal number of lags for LnY based on FPE formula in this equation. In this formula T is total number of observations m is number of lags for LnY and SSR (m,0) is sum of squared residuals only with m lags. In the second step we add the other variable to the equation(for example LnTEC), and discern appropriate number of lags for new variable(n) with identified lags of first variable(m) and based on minimum FPE. In this step we calculate the FPE with new formula. Equation 5 shows this formula, in this formula n is number of lags for new added variable, and also SSR (m,n) is sum of squared residuals based on m and n lags. Now we

can judge about causality. If calculated FPE in the second equation or in the second step be smaller than first equation's FPE we can say there is a causality relation which runs from new added variable (for example LnTEC) to the first variable (for example LnY). We employ the same procedure for other variables. Some of the past researchers employed this approach to investigate energy consumption-GDP relationship (see Hao-Yen Yang(2000), for Taiwan; Galip Altinay and Erdal Karagol(2004), for Turkey).In this study we included only six countries of the Middle East for investigation because the data in many of other countries were not I(0) or stationary at the level, therefore we can not use conventional granger causality test about them.

$$L_n Y_t = \lambda + \sum_{j=1}^{m} \beta_j L_n Y_{t-j} + \varepsilon_t \quad , \quad FPE(m,0) = \left(\frac{T+m+1}{T-m-1} \right) \left(\frac{RSS(m)}{T} \right) \quad (3)$$

$$L_n Y_t = \mu + \sum_{j=1}^{m} \beta_j L_n Y_{t-j} + \sum_{i=1}^{n} \alpha_i L_n X_{t-i} + v_t$$

$$FPE(m,n) = \left(\frac{T+m+n+1}{T-m-n-1} \right) \left(\frac{RSS(m,n)}{T} \right) \quad (4)$$

$$L_n X_t = \theta + \sum_{i=1}^{n} \alpha_j L_n X_{t-i} + e_t \quad (5)$$

$$L_n X_t = \delta + \sum_{i=1}^{n} \alpha_j L_n X_{t-i} + \sum_{j=1}^{m} \beta_j L_n Y_{t-j} + \mu_t \quad (6)$$

4- Empirical results

Table 2 shows the results for LnY and LnTEC for Bahrain.According to this table second equation's FPE is smaller than first equation's FPE (0.000514<0.001272). This indicates a causality relation from total energy consumption to GDP (lnTEC→ LnY).And also final prediction error of fourth equation is smaller than third (0.002723<0.00287) and indicates a causality relation from LnY to LnTEC (lnY → LnTEC).According to the results of table2 we have bidirectional causality relation between total energy consumption and GDP for Bahrain which supports the feedback

hypothesis.Table3 displays the results for other countries.In this table m is the number of appropriate lags for GDP and n is number of appropriate lags for total energy consumption(TEC).According to the results we have bidirectional causality effect for all countries except Saudi Arabia and Iran.Therefore for these countries(Oman,Bahrain,Pakistan and the United Arab Emirates)a high level of economic growth leads to high level of energy demand and vice versa.There is a unidirectional causality effect for Saudi Arabia running from GDP to total energy consumption, and supports the conservation hypothesis. In another words energy conservation policies would not be harmful for economic growth. There is a unidirectional causality effect for Iran running from energy consumption to GDP which supports the growth hypothesis.Therefore policies on energy conservation may negatively affect economic growth. These results support the findings of Masih and Masih(1996) for Pakistan.But for Iran the results don't support the empirical findings of Gudarzi and Soheli Ghasemi(2012). According to their findings there is unidirectional granger causality running from GDP to energy consumption and energy saving would not harm economic growth in Iran. The results for Saudi Arabia support the findings of Mahmoud A. Al-Iriani (2006).But for UAE,Oman and Bahrain the results are not consistent with his empirical findings. His findings indicate a unidirectional causality running from GDP to energy consumption. The difference of the results with some of previous studies may be attributed to the new method proposed by Hsiao(1981) and also period of study.

Table 2: Total Energy Consumption and GDP Causality Results for Bahrain

Equation	Causality Relation	Minimum FPE
$L_n Y_t = \lambda + \sum_{j=1}^{7} \beta_j L_n Y_{t-j}$	LnY $\rightarrow$ LnY	0.001272
$L_n Y_t = \mu + \sum_{j=1}^{7} \beta_j L_n Y_{t-j} + \sum_{i=1}^{8} \alpha_i L_n TEC_{t-i}$	LnTEC $\rightarrow$ LnY	0.000514
$L_n TEC_t = \theta + \sum_{i=1}^{8} \alpha_i L_n TEC_{t-i}$	LnTEC$\rightarrow$ LnTEC	0.00287
$L_n TEC_t = \delta + \sum_{i=1}^{8} \alpha_i L_n TEC_{t-i} + \sum_{j=1}^{4} \beta_i L_n Y_{t-j}$	LnY $\rightarrow$ LnTEC	0.002723

Table 3: Hsiao's (1981) Causality Test Results

IRAN	Optimal lag length	Minimum FPE	Causality Result
LnY→LnY	m=9	0.00087	-
LnTEC →LnY	m=9,n=1	0.00049	Accept
LnTEC →LnTEC	n=4	0.00207	-
LnY → LnTEC	m=1,n=4	0.00222	Reject
PAKISTAN			-
LnY→ LnY	m=2	0.000288	-
LnTEC →LnY	m=2 ,n=2	0.000279	Accept
LnTEC→LnTEC	n=1	0.001135	-
LnY→ LnTEC	m=1 ,n=1	0.000954	Accept
SAUDI ARABIA			-
LnY→LnY	m=10	0.001295	-
LnTEC →LnY	m=10 ,n=1	0.001548	Reject
LnTEC→ LnTEC	n=2	0.00525	-
LnY→ LnTEC	m=3 ,n=2	0.00451	Accept
U.A.E			-
LnY→LnY	m=9	0.00278	-
LnTEC →LnY	m= 9,n=8	0.00234	Accept
LnTEC →LnTEC	n=10	0.00418	-
LnY → LnTEC	m=3 ,n=10	0.00111	Accept
BAHRAIN			-
LnY→LnY	m=7	0.001272	-
LnTEC →LnY	m=7 ,n=8	0.000514	Accept
LnTEC →LnTEC	n=8	0.00287	-
LnY→ LnTEC	m=4 ,n=8	0.002723	Accept
OMAN			-
LnY→LnY	m=10	0.001085	-
LnTEC →LnY	m=10 ,n=8	0.000176	Accept
LnTEC →LnTEC	n=10	0.010101	-
LnY→ LnTEC	m=6 ,n=10	0.0043	Accept

5- Conclusions

In this paper we investigated energy consumption-GDP relation for selected countries of the Middle East.We used annual data spanning the period 1980-2012.Thanks to the stationary variables we employed Hsiao's(1981) methodology to discern optimal number of lags for the model.The results indicate there is bidirectional causality effect for Pakistan,Oman,Bahrain and the United Arab Emirates, which indicates the feedback hypothesis about these countries.There is a unidirectional causality effect for Iran running from total energy consumption to GDP which supports growth hypothesis.This indicates that energy conservation policies may negatively affect on economic growth. And also there is a unidirectional causality relation running from GDP to total energy consumption for Saudi Arabia.Therefore we can accept the conservation hypothesis for Saudi Arabia.Energy conservation policies can not be harmful for economic growth in Saudi Arabia.

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