THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND ECONOMIC GROWTH: THE CASE OF OPEC MEMBER COUNTRIES

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Abstract. Last decade can be called as economic and industrial development decade. Development process of economic processes has been accelerated in recent years. With the onset of the industrial revolution and forming machine industry, energy became as one of the primary and most important factors of manufacturing in industry. This research studies the relationship between energy consumption and GDP, imports and exports of OPEC countries over the period of 1990-2014 were analyzed using panel data. The results showed that the growth of GDP, exports and imports has positive and significant effect on energy consumption in countries that were studied. Finally, the researcher suggests to reduce energy consumption and increase the efficiency of production, an increase in productivity of production technology and modernization of production equipment is essential.

Key words: GDP, imports, exports, energy consumption, selected countries of OPEC, panel data

1. Introduction

Evolution of the economy in the last century, has been associated with variety of energy applications but in the seventies oil shocks and economic recession in the West, caused role of energy to have a special place in economic developments and in the eighties the relationship between energy consumption and economic growth to be the focus of economic analysts (Sadorsky, 2011). During the last thirty years, many emerging and developing economies, have experienced rapid growth in trade, production and energy consumption and many studies have been done on the relationship between energy consumption and GDP (Dedeoglu and Kaya, 2013).

Studying relationship between energy and trade from different directions is important. If energy consumption is cause of export or import, any reduction in energy consumption such as energy-saving policies, will reduce export or import and trade benefits and will neutralize trade liberalization policies that are designed to boost economic growth. In fact, in these conditions, energy conservation policy is in contrast with the policies of trade liberalization. But if there is one-way causality from export or import to energy, energy saving policies won't have mentioned negative effects (Sadorsky, 2011).

Countries studied in this research which included selected OPEC member countries are the world's major oil exporters and OPEC members. The importance of energy consumption in these countries arises since that, firstly, since the country's income is mainly from oil, looses a lot of financial resources by inefficient use of energy inside; secondly as time goes on fossil energy sources or the oil and gas reduces in exporting countries. So if these countries won't make their energy consumption more efficient or not reform their infrastructures, will face serious problems in next few years (Mukherjee and Chakraborty, 2010).

The aim of this study is to investigate the relationship between energy consumption and economic growth in selected countries of OPEC during the period 1990-2014 using panel data.

2. Review of empirical literature

Sadorsky (2011) also introduces and estimates an empirical model of renewable energy consumption for countries in the group7 for the period of 1980-2005. Co-integration Panel estimates in this study shows an increase in real per capita GDP and Carbon dioxide emissions per capita is as the main drivers for renewable energy consumption per capita in the long term. On the other hand, rising oil prices have had small and negative effect on renewable energy consumption. According to the research findings, long-term elasticity estimated by the cointegration panel of FMOLS model show that 10% increase in real per capita GDP, 8.44 percent increases renewable energy consumption. While 1 percent increase in per capita carbon dioxide will increase 5.23% per capita consumption of renewable energy.

Apergis et al. (2010), test the causal relationship between carbon dioxide emissions, nuclear energy, renewable energy and economic growth for a group of 19 developed and developing countries for the period of 1984 to 2007 using error correction panel model. They have expressed bidirectional relationship between renewable energy and economic growth means that Expansion of renewable energies will not only can reduce dependence on external energy sources for import-dependent economies, but also this factor can reduce the risk resulting from fluctuations in the supply of natural gas, oil and prices.

Deedgula and Kaya (2013) in a study evaluated the relationship between energy consumption, export, import and GDP for OECD countries over the period of 1998 to 2010 using integration panel method and use of Granger causality test. The model was estimated for this purpose have been as follows:

Energy= F (GDP, Import, Export)

In top model the Energy is energy consumption, Import is import and GDP is based on 2005 fixed price and the Export is export.

At first existence of long-term relationship is evaluated using co-integration regression in model and after securing the long-term relationship between the research variables investigated the causal relationship between energy consumption with import, export and GDP (Armen and Zare, 2010). The results showed that export, import and GDP have significant and positive relationship with energy consumption. Other results of the research showed that there is bidirectional Granger causality relationship between energy consumption-GDP, energy consumption-export and energy consumption-import and mark of long-term stretch between variables is positive so that one percent increase in GDP, exports and imports respectively causes an increase of 0.32, 0.21 and 0.16 percent in energy consumption (Zellner, 1962).

Behboodi et al. (2010) in an article entitled "Study of the relationship between energy consumption and GDP in developing and developed countries" studied use of Johansen cointegration test. The results showed that in the long run there is two cointegrating vector between variables in selected developing and developed countries. Although these two vectors are different, during the studied period developed countries are in higher level of energy consumption than developing countries and amount of long-term impact of energy consumption on GDP in these countries is less than developing countries.

Maleki (2015) in a study investigated the causal relationship between energy consumption and economic growth over the period of 1360-1380. The results of estimated model showed that any changes in energy consumption both in the short and in the long run could affect economic growth, so that any limitation in its use can reduce economic growth.

3.   Model and analysis of data

The model used in this study is as follows that is adapted from Ting-Huan et al. (2010) research:

Energy= F (GDP, Import, Export)

In the above model the Energy is energy consumption, import, and GDP is based on 2005 fixed price and the export.

This research is based on combined data methods. When the panel data is used different tests should be done for diagnosing the proper estimation method. The most common test in this field is Chow test and Hausman test. Chow test is used to test between ordinary least squares method and the fixed effects model. In this test, the null hypothesis expresses the equality of coefficients and intercept in studied data. Thus, rejection of the null hypothesis indicates using panel data and not rejecting the null hypothesis indicates using merged ordinary least squares method. If it is determined in Chow test that separate intercepts can be considered for all sections or times In this study, then

should attempt to test choose between estimates with group or time random-effects. The main assumption in fixed effects model is that error term could be correlated with the explanatory variables, while in random effects model it is assumed that there is no correlation between error term and explanatory variables. Hausman test also uses chi-square criteria. If the probability of the test statistic is more than 5%, at the significant level of 0.95 % random effects can be preferred to fixed effects; otherwise fixed effects are chosen.

4 Model estimation

According to what was said desired model is estimated using panel data. The results of estimated model are in following.

If time series variables are non-stationary, the coefficients will lead to a spurious regression. In the first stage unit root and co-integration test of panel takes place on model variables in order to prevent spurious regression. In this study, the Levin, Lin and Chow tests are used. The null hypothesis of test indicates non-stationary of variables.

Table 1: unit root test on the level and the difference of variables

Variables	Levin, Lin & Chu (First difference of variables)		Levin, Lin & Chu (level of variables)		scollective degree
	Statistic	Probability	Statistic	Probability	
GDP	-11.22	0.000	1.96	0.97	I(1)
Energy	-	-	-7.70	0.000	I(0)
Export	-	-	-17.84	0.000	I(0)
Import	-	-	2.76	-3.76	I(0)

Source: Researchers findings

As Table 1 shows that all research variables are static except GDP, but first difference of GDP is static. In other words, GDP are I (1).

Cao co-integration test is used to prove non-falseness of regression in this study. T statistic value in Cao's test is obtained as (3.25-) and the P-Value equals (0.003) which confirms the existence of co-integration so it can be said that there is a long-run balance relationship between independent and dependent variables. After securing co-integration relationship, it is

necessary to determine the type of panel data estimation method in order to estimate the model. So, initially to determine the presence or absence of a separate intercept for each of these countries the F-statistic is used. Then, the Hausman test is used to test if the model is estimated by fixed effects method or random effects. The results of the F test, confirm estimation of model using fixed effects. Hausman test also indicates approval of fixed effects model against the random effects. Table 2 shows the results of Chow and Hausman test.

Table 2: Results of Chow and Hausman tests

Type of test	Significant level	Test statistic	Type of test	test results
Chow test	0.000	151.54	Chow test	Approval of fixed effects model against the pooling data model
Hausman test	0.000	22.26	Hausman test	Approval of fixed effects model against random effects

Source: Research results

The results of model estimation with fixed effects is shown in table (3).

Table 3: Model estimation with fixed effects

Dependent variable : Energy			
Explanatory variable	compound data test		
	Prob	T-statistic	Coefficient
GDP	0.05	1.890	0.630
Import	0.021	2.25	0.180
Export	0.000	5.69	0.277
Constant	0.0000	-24.48	-11285.9
F statistic	265.96		
P-value	0.0000		
R^2	0.87		
Adjusted R^2	0.88		
DW	1.96		

Source: research results

Based on the results of table (3), F test represents significant of the regression. Based on other results, the variable GDP, has positive and significant effect on energy consumption in the studied countries. expressly, the increase of production, has

increased the energy consumption in this countries. In some new theories, although the energy factor together with other factors is considered in the model, but its importance in various models, is not the same. Thus, according to existing theoretical

foundations, about justification of the relationship between energy consumption and GDP, existence of such relationship can be rationally logical and considered theoretically. Also the import factor has significant and positive effect on energy consumption. In fact, the increase in imports has increased the energy consumption in studied countries. Import and export variable, have had significant and positive effect on energy. Also the increase in exports and imports and has increased the energy consumption in these countries (Angeliki, 2011). Specifically trade includes exports and imports of goods and theoretically there are several reasons for why exports could affect energy consumption. To make growth happen in exports, machinery and equipment for loading and transportation of exported goods should be sent to ports, airports or unloading stations. Machinery and equipment in the manufacturing process and transportation of goods for export, are in need of primary energy and any increase in exports, represents growth of economic activity and this growth will increase energy demand. So the export of manufactured goods require energy for transportation, means without enough energy to transport, the export expansion will be weakened. Imports can also affect energy consumption. If importing include machinery, equipment and new technology will cause an increase in production and increased use of energy. In addition, imports of goods are done through the transport network which causes the fuel consumption by the transport system (Stern and Cleveland, 2004).

5 Conclusions

Nowadays issues related to energy consumption and amount of its consumption in different sectors, is one of the most important issues in policy and planning of countries. In this study, the relationship between energy consumption and GDP, importing and exports of selected countries in the Islamic Middle East during the period of 2014-1990 were analyzed using panel data. The results showed that GDP, importing and export have had significant and positive effect on energy consumption in studied countries (Akarca and Long, 1979). Suggestions of this research is presented in two parts for studied countries in general and Iran in particular:

According to results of this study and export and import's direct effect on energy consumption, in the absence of a systematic program, increased demand for energy, could have adverse effects on the environment. So it is recommended to run strategies to reduce energy consumption in the transport sector, especially in the export and importing of goods so that we can reduce the amount of pollution emitted by vehicles. Based on previous studies, the use of rail freight is one of the best ways of transporting in terms of pollution. In Iran, one of the goals and visions of economic development, is to achieve first place in economic, science and technology in the South West Asia with an emphasis on software movement and science production, rapid and continuous economic growth, and the relative improvement per capita income in reaching full employment. According to conjunction of oil and gas markets in the world, in the shadow of economic globalization and nonrenewable energy and resource scarcity, oil embargo against Iran, will reduce pace of development of energy resources in Iran. Therefore increase in productivity of production technology and modernization of production equipment is essential in order to reduce energy consumption and increase the efficiency of production.

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