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Foreign Trade, Population and Energy Consumption: Evidence from Selected Oil Producing Countries

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Abstract

The increasing importance of energy in the formation and development of economic processes and the need to exploit this valuable resource highlights identification of the factors that influence energy consumption. In this paper, the effects of foreign trade, population, oil prices, income and value added of economic sectors (agriculture and industry) on energy consumption have been studied. To estimate the effects of variables, the econometric techniques of panel data with the method of generalized least squares (GLS) and generalized moments (GMM) has been employed. Empirical results from analyzing 21 selected oil producing countries during the period 1999-2010, show that foreign trade (sum of exports and imports), population, income and value-added of economics sectors have a positive impact while oil prices have a negative impact on energy consumption. Also, in order to realize the more detailed results, separately analysis of exports and imports suggest that the effect of exports and imports on energy consumption is positive. According to research findings in terms of price elasticity of demand, energy is a good with a low elasticity of demand, while in the case of income elasticity energy has been found as a necessary good.

Keywords: energy consumption, panel data, population, trade, unit root

Introduction

Nowadays energy as a factor of production along with other factors such as labor, capital and raw materials plays a determinant role in the economy of countries. Economic developments in recent decades have been associated with the use of energy diversification, so in the late seventies, the oil shock along with the recession in the West caused important role for energy in economic development. The relationship between energy consumption and influencing factors puts it at the center of analysis. Needs of the different economic sectors to energy is a reality that cannot be unconcerned to it. Inattention to this can create irreparable damage to the country's development process. The rapid economic and industrial development in developing countries, largely related to the level of energy consumption, as a result energy is accounted for a significant contribution in the world trade and activity. Foreign trade is the most controversial parts of the economy. Most economists consider foreign trade as an engine of economic growth; in this way due to oil transactions the business of the number of countries was featured, and this has led many countries to join the World Trade Organization (WTO), and removed the economic borders (Sadorsky, 2011). On the other hand, the increasing and indiscriminate use of different energy carriers due to the increasing world population growth rate has attracted the attention of countries to two important issues: the finitude of fossil fuels and environmental pollution(Chiang and Chiu, 2012).Government policy for energy management is a step toward reducing energy consumption, Therefore, determination of the relationship between energy consumption and the affecting variables can contribute to policymaking in energy sector (Kebede and et al, 2010).

The basic question of this research is how the increase in trade and population impacts on energy consumption? Since in the most studies on the relationship between energy consumption and major macroeconomic variables, the impact of foreign trade and population on energy consumption hasn't been concerned in especially oil producing countries, employing panel data techniques with generalized Least Squares and moments approach this paper tries to investigate the effects of trade, population, income, oil prices and value added of industry and agriculture sectors on energy consumption in 21 selected oil producing countries over the period 1999-2010. Also, in order to realize the more detailed results of the overall foreign trade (sum of exports and imports), separate analysis in the case of export and import have been conducted.

This paper is organized as follows: After the introduction, the second section will review the theoretical and empirical literature. Research methodology is discussed in Section three. Research findings are presented in the fourth section. Section five is devoted to conclusions and recommendations.

Review of literature

Trade and its relationship with energy consumption as a very important issue are investigable from different angles. International trade is transportation of goods and services between borders of countries and commercial trade includes import and export transactions and circumstances that these transactions take place. Many economies have experienced a dramatic raise in trade and energy over the past 30 years, however, little information exists on the relationship between trade and energy. This raises an interesting question in our minds, how to increase the impact of trade on energy use? International trade requires an efficient transport network. Movement of goods through the airline, rail, road and water transport systems needs energy. Almost 30 percent of the world's total energy demand is in the transport sector (Sadorsky, 2011). Growth in world trade in recent years, only with increases in production, and marketing of these products has not been possible, but means of transport have played a significant role in the transaction of goods between different parts of the world. Transport sector has the strongest backward and forward linkages with business sector. There are several reasons why exports could theoretically influence the energy consumption.

In order to take place growth in exports, export goods should be sent to ports, airports or loading stations. Machinery and equipment in the production process and transport of goods for export need the basic energy. Any increase in exports is a sign of economic activity growth and lead to raises in energy demand. Imports can also affect energy consumption. If imports include machinery, equipment and new technology, production and energy uses will increase. In addition, imports of goods which are take place through the transport network energy consumption result in use of energy by transport system (Sadorsky, 2012).

In addition to trade, population also has inevitability link with energy consumption and its clarification can help to the adoption of energy efficient policies. The population growth and rising young people and adults, and in particular urban population, will increase demand for energy products (Ehrlich and Ehrlich, 2004). Increase in energy consumption due to urbanization also seems obvious. Urbanization and stable development of it induce need to growth in the energy carriers. Along with urbanization, the use of traditional energy decreases while the demand for energy, transport and trade increases (Kebede et al, 2010).

There have been relatively few analyses in investigation of the dynamic relationship between trade and energy consumption in the oil producing countries. In view of the key role of energy in the world economy, a growing interest in examining the impact of trade on energy consumption has been established in empirical studied.

Morikawa (2012) investigates the impact of population growth on energy consumption in the selected countries. Employing panel data technique he shows that there is positive relationship between two variables. Granger causality between trade and energy consumption has been investigated by Sadorsky (2012). Empirical findings suggest that export and import cause consumption of energy in log term at seven South American countries. In the other study, using panel co-integration technique Sadorsky (2011) shows the positive relationship between export also import and energy consumption at eight Middle East countries. Ghani (2012) examines the effect of trade liberalization on energy consumption in developing countries over the period 1970-1999. Employing panel data approach he finds that trade liberalization has no impact on energy consumption. ARDL technique has been employed by Halicioglu (2011) to analyze the relationship between export and energy consumption in Turkey. Empirical findings for the 1968-2008 periods demonstrate positive impact of export on energy consumption. Kahrl and Roland (2008) use the input-output table method to inspect the relationship between export and energy consumption in China. Empirical results provide evidence of low impact of export on energy consumption.

In the light of the mixed empirical results in the literature, we are motivated to find the empirical support for the static and dynamic relationship between trade and energy consumption in the oil producing countries.

Methodology

In this research, employing econometric techniques of panel data with the method of Generalized Least Squares (GLS) and generalized moments (GMM), the effects of foreign trade, population, oil prices, income and value added of economic sectors (agriculture and industry) on energy consumption have been investigated in 21 selected oil producing countries[1] during the period 1999-2010. Following Sadorsky (2011) and Kebede et al. (2010) based on theoretical literature the empirical econometrics models have been modified as:

$$LnE_{it} = \alpha_{1i} lnO_{it} + \alpha_{2i}\, lnPOP_{it} + \alpha_{3i}\, lnY_{it} + \alpha_{4i}\, ln\mathrm{OPR}_{it} + \alpha_{5i}\, ln\mathrm{IND}_{it} + \alpha_{6i}\, ln\mathrm{AGR}_{it} + \varepsilon_{it} \qquad (1)$$

$$LnE_{it} = \alpha_{1i} lnX_{it} + \alpha_{2i}\, lnPOP_{it} + \alpha_{3i}\, lnY_{it} + \alpha_{4i}\, ln\mathrm{OPR}_{it} + \alpha_{5i}\, ln\mathrm{IND}_{it} + \alpha_{6i}\, ln\mathrm{AGR}_{it} + \varepsilon_{it} \qquad (2)$$

$$LnE_{it} = \alpha_{1i} lnM_{it} + \alpha_{2i}\, lnPOP_{it} + \alpha_{3i}\, lnY_{it} + \alpha_{4i}\, ln\mathrm{OPR}_{it} + \alpha_{5i}\, ln\mathrm{IND}_{it} + \alpha_{6i}\, ln\mathrm{AGR}_{it} + \varepsilon_{it} \qquad (3)$$

Where LE is the logarithm of energy consumption; LO is the logarithm of real total trade (sum of export and import); LX is the logarithm of real export; LM is the logarithm of real import; POP is the logarithm of total population; LOPR is the logarithm of real oil prices; LI is the logarithm of real income; LIND is the logarithm of real value added of industry sector; LAGR is the logarithm of real value added of agriculture sector and ε is error term. These values are converted to real values by dividing by the consumer price index (2005 has been considered as the base year). Data on energy consumption, income, population, exports and imports and consumer price index are obtained from the World Bank (WDI, 2013). Data on oil prices also compromised from British Petroleum Statistical Review of World Energy (2013).

[1].Algeria, Angola, Argentina, Australia, Azerbaijan, Brazil, Canada, China, Colombia, Egypt, Arab Rep, India, Indonesia, Iran, Islamic Rep, Malaysia, Mexico, Norway, Russian Federation, Saudi Arabia, Sudan, United Kingdom, United States.

To ensure the absence of spurious regressions, unit root and co-integration tests have been employed to check and verify stationary property and long-term relationship between the studied variables. Furthermore, after applying identification tests, estimation method to estimate has been determined. Finally the models have been estimated in two modes static and dynamic.

Empirical results

Panel Unit Root Test

The unit root tests are fairly similar in showing that, except for the test on the population variable, for each series in levels the null hypothesis of a unit root cannot be rejected at the 5% level while for each series in the first differences, the null hypothesis of a unit root can be rejected (table1 and table2).

Table 1. Panel unit root test at level

Variable	Im, Pesaran and Shin(levels)	
	Statistic	Prob.
LnE	-0.63055	0.2642
LnO	0.49498	0.6897
LnX	0.44136	0.6705
LnM	-0.12042	0.4521
LnPOP	-12.8239	0.0000
LnY	-1.51763	0.0646
LnP	0.33487	0.6311
LnIND	-0.87923	0.1896
LnAGR	-1.05575	0.1455

Table 2. Panel unit root test at first differences

Variable	Im, Pesaran and Shin(First differences)	
	Statistic	Prob.
D(LnE)	-4.60909	0.0000
D(LnO)	-3.49174	0.0002
D(LnX)	-3.53934	0.0002
D(LnM)	-2.68122	0.0037
D(LnPOP)	-11.4242	0.0000
D(LnY)	-2.38113	0.0086
D(LnP)	-6.42801	0.0000
D(LnIND)	-2.17813	0.0147
D(LnAGR)	-3.47089	0.0003

Panel Cointegration Test

Since the variables in first differences are stationary, it is necessary to check the co-integration of variables. The results of performing Kao panel co-integration test for the data set in table 3, providing evidence of co-integration at the 5% level.

Table 3. Panel cointegration test to model (1)

Kao Cointegration		
	t-Statistic	prob
ADF	-5.114254	0.0000

Table 4. Panel cointegration test to model (2)

Kao Cointegration		
	t-Statistic	prob
ADF	-5.340603	0.0000

Table 5. Panel cointegration test to model (3)

Kao Cointegration		
	t-Statistic	prob
ADF	-4.443495	0.0000

In other words, the results of table 3 suggest that there is a strong long run relationship between trade, population, income, oil prices, value added of agriculture and industry sectors and energy consumption. In the same way, table 4 provides evidence of the existence a strong long run relationship between export, population, income, oil prices, value added of agriculture and industry sectors and energy consumption. In addition, the existence of a strong long run relationship between import, population, income, oil prices, value added of agriculture and industry sectors and energy consumption is confirmed by the empirical results in table 5. Therefore, regarding to empirical results from Kao panel co-integration test it can be noted that although the variables are stationary in the first difference but they are co-integrated in level (Kao and Chiang, 1999).

Estimate by the Generalized Least Squares method

In order to determine type of estimation method (panel or pooling methods), it is necessary to perform diagnostic tests. If the calculated F-statistic from Fixed Effects test is greater than the F table, the null hypothesis of equal intercepts is rejected and different intercepts should be considered in the model. Consequently, the panel method can be used to estimate the model. Also in order to opt fixed or random effects methods, Hausman test is calculated. In Hausman test the null hypothesis of consistent random effects estimations is tested (see Baltagi, 2005). In the following, the diagnostic tests for each modified models will be explained in detail.

In the case of model (1), table 6 shows the rejection of the null hypothesis of equal intercepts implying use of panel method in the estimation process.

Table 6. Fixed effects test to model (1)

Effects Test	Statistic	d.f.	Prob.
Cross -Section F	369.739443	(20,220)	0.0000
Cross-section Chi-square	875.422338	20	0.0000

Table7. Hausman test to model (1)

Test Summary	Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	126.605336	6	0.0000

According to results from Hausman test (table 7) the fixed effects method should be used for estimating model (1).

Table 8 represents the empirical results from estimating model (1)[2]. Thus, trade, population, income and value added of agriculture and industry sectors have positive impact on energy consumption and are significant at the 5% level, while the effect of oil price on energy consumption

[2] In order to avoid the time correlation between sections and heteroskedasticity in estimating models (1), (2) and (3) the cross section weight method has been employed.

is negative. Regarding estimation results it can be noted that price elasticity of energy demand is -0.06 percent implying energy is a good with a low elasticity of demand. Income elasticity of energy demand (0.16 percent) also suggests that energy is a necessary good.

Table 8. The estimation results to model (1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-24.73370*	1.371844	-18.02952	0.0000
LO	0.107573*	0.021017	5.118435	0.0000
LPOP	1.828637*	0.080682	22.66472	0.0000
LY	0.166548*	0.049658	-3.353876	0.0009
LP	-0.063345*	0.013571	-4.667644	0.0000
LIND	0.074917***	0.045290	1.654170	0.0995
LAGR	0.174142*	0.029238	5.955948	0.0000
R-squared	0.998796			
Adjusted R-squared	0.998653			
Durbin-Watson stat	1.801276			
n	252			
*, ***indicate statistical significance at the 1% and 10% levels, respectively.				

The results from the fixed effect test in table 9 provide evidence for employing panel technique for estimating model (2). The outcomes from Hausman test confirm using fixed effects method in estimating process (table 10).

Table 9. Fixed effects test to model (2)

Effects Test	Statistic	d.f.	Prob.
Cross -Section F	347.376401	(20,220)	0.0000
Cross-section Chi-square	860.471074	20	0.0000

Table 10. Hausman test to model (2)

Test Summary	Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	124.408075	6	0.0000

Table 11. The estimation results to model (2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-23.26810*	1.342937	-17.32628	0.0000
LX	0.046915**	0.021462	2.185939	0.0299
LPOP	1.771999*	0.077524	22.85750	0.0000
LY	0.131378*	0.047750	-2.751351	0.0064
LP	-0.040428*	0.014055	-2.876423	0.0044
LIND	0.083853***	0.043334	1.935041	0.0543
LAGR	0.170070*	0.028975	5.869601	0.0000
R-squared	0.998587			
Adjusted R-squared	0.998420			
Durbin-Watson stat	1.779655			
n	252			
*, **, ***indicate statistical significance at the 1%, 5% and 10% levels, respectively.				

Estimation results from model (2) have shown by table 11. As a result, export has a positive impact on energy consumption. Other variable influences the energy consumption as the results from model (1). Based on the empirical findings in table 11, concerning the price elasticity of energy demand (-.04 percent) and income elasticity of energy demand (0.13 percent) energy is low demand elasticity and necessary good respectively in the studied countries. Tables 12 and 13 provide evidence for employing panel technique and fixed effects method to estimate model (3).

Empirical findings in table 14 from estimating model (3) confirm the positive impact of import on energy consumption. The effects of other variables are similar to findings of model (1) and model (2) estimations. In model (3), the price elasticity of energy demand and income elasticity of energy demand are -0.06 and 0.22 percent respectively in the studied countries.

Table 12. Fixed effects test to model (3)

Effects Test	Statistic	d.f.	Prob.
Cross -Section F	400.323116	(20,220)	0.0000
Cross-section Chi-square	894.506500	20	0.0000

Table 13. Hausman test to model (3)

Test Summary	Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	129.537784	6	0.0000

Table 14. The estimation results to model (3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-24.58051*	1.382749	-17.77655	0.0000
LM	0.124715*	0.016821	7.414264	0.0000
LPOP	1.841065*	0.080184	22.96040	0.0000
LY	0.226449*	0.043586	-5.195424	0.0000
LP	-0.066440*	0.012452	-5.335716	0.0000
LIND	0.125314*	0.038716	3.236797	0.0014
LAGR	0.154337*	0.028157	5.481246	0.0000
R-squared	0.998853			
Adjusted R-squared	0.998718			
Durbin-Watson stat	1.855316			
n	252			
* indicate statistical significance at the 1% level, respectively.				

Estimate by the generalized method moments (GMM)

A major problem in using conventional methods such as least square and maximum likelihood methods is these estimators are inconsistent for panel dynamic parameters in the high number of observations and short study period circumstances. Also some common assumptions in the regression model such as independence error terms with explanatory variable may not hold. To overcome these issues, other technique such as instrument variables is suggested. Since the number of obtained estimators based on these variables (instrument variables) is so many for a specified parameter, the Generalized Method of Moments (GMM) as an alternative approach is proposed to estimate linear dynamic panel model.

The Generalized Method of Moments has been used to estimate dynamic panel of three specified models .In this approach dependent variable with one lag is defined as an explanatory variable in the model. In order to check the credibility of explanatory variables, Wald test has been employed. The null hypothesis of this test is equality of all of coefficients to zero (insignificancy of the specified model). If this hypothesis is rejected the credibility of explanatory variables will approved. Also in order to check the credibility of instruments the Sargan test has been used. The null hypothesis of this test is that there is no correlation between instruments and error terms (see Baltagi, 2005).

Table 15. The estimation results to model (1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LE(-1)	0.757100*	0.066201	11.43640	0.0000
LO	0.010037***	0.035153	0.285522	0.0755
LPOP	0.492147*	0.143456	3.430655	0.0007
LY	0.210760*	0.062569	-3.368448	0.0009
LP	-0.022718**	0.015342	1.480789	0.0400
LIND	0.115277**	0.057038	2.021031	0.0444
LAGR	0.097518*	0.035055	2.781844	0.0058
	Value		Prob.	
Wald Test	2027.119		0.0000	
Sargan Test	105.8775		0.539795	
*, **, *** indicate statistical significance at the 1%, 5% and 10% levels, respectively.				

The empirical findings of model (1) estimation using GMM technique have been shown in table 15. As it can be seen, the impact of trade, population, income and value added of agriculture and industry sectors variables on energy consumption is positive, while the coefficient of oil price is negative. The results from Wald and Sargan tests confirm the credibility of estimated coefficients and estimation findings.

Table 16 and 17 show the empirical results of applying GMM technique to estimate models (2) and (3). The positive relationship between export, import, population, income and value added of agriculture and industry sectors variables and energy consumption has been confirmed by these findings. Also the credibility of estimated coefficients and instrument variables are verified by the results of employing the Wald and Sargan tests.

Conclusions

The aim of this research is investigating the impact of the impact of trade, population, income and value added of agriculture and industry sectors variables on energy consumption. To this end, using econometric techniques of panel data with the method of Generalized Least Squares (GLS) and generalized moments (GMM) the behavior of energy consumption has been studied over the period 1999 to 2010 at 21 selected oil producing countries. Three different scenarios have been designed to analysis the impacts of trade as sum of export and import, export and import separately.

Empirical findings suggest that there is a positive relationship between trade, population, income and value added of agriculture and industry sectors variables and energy consumption in the under studied countries. On the other hand, the negative impact of oil price has been confirmed by the estimation results. On the bases of research findings it can noted that in these countries energy in terms of price elasticity of demand is a good with a low elasticity of demand, while in terms of income elasticity it has been found as a necessary good.

Given the positive relationship between trade and energy consumption, it is necessary to adopt and implement reasonable and consistent policies regarding to its role in the trade process and provide the conditions for sustainable development.

Table 16. The estimation results to model (2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LE(-1)	0.716352*	0.069338	10.33134	0.0000
LX	0.051677***	0.031177	-1.657506	0.0987
LPOP	0.591483*	0.150190	3.938234	0.0001
LY	0.254718*	0.069222	-3.679706	0.0003
LP	-0.035386**	0.015609	2.267046	0.0243
LIND	0.204405*	0.066862	3.057140	0.0025
LAGR	0.091623*	0.035175	2.604807	0.0098
	Value		Prob.	
Wald Test	1935.005		0.0000	
Sargan Test	102.8939		0.620766	
*, **, *** indicate statistical significance at the 1%, 5% and 10% levels, respectively.				

Table 17. The estimation results to model (3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LE(-1)	0.728673*	0.064708	11.26085	0.0000
LM	0.060125**	0.024195	2.484990	0.0136
LPOP	0.543940*	0.143629	3.787130	0.0002
LY	0.259410*	0.062550	-4.147222	0.0000
LP	-0.012006*	0.014257	0.842080	0.0006
LIND	0.125447*	0.045550	2.754046	0.0002
LAGR	0.097983*	0.034266	2.859472	0.0046
	Value		Prob.	
Wald Test	2075.353		0.0000	
Sargan Test	104.9206		0.565946	
*, ** indicate statistical significance at the 1% and 5% levels, respectively.				

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