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Energy consumption and economic growth in oil importing and oil exporting countries: A Panel ARDL approach

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Abstract[1]

In this paper, we examine the relationship between energy consumption and economic growth in selected oil exporting and oil importing countries using annual data form from 1980 to 2014. The paper contributes to the extant literature on energy consumption-growth nexus in the following three ways. First, it compares energy consumption-growth nexus of oil importing countries with that of oil exporting countries. Second, it accounts for any inherent heterogeneity feature of these categories of countries as well as non-stationarity concern in long panels by using the mean group and pooled group estimators. Thirdly, it employs Panel ARDL model which facilitates the estimation of both long run and short run elasticities in panel form. From the empirical analysis, we find that, in the long run, energy consumption has positive and significant effect on economic growth both for oil exporting and oil importing countries although the effect is observed to be higher for the former than the latter. In the presence of shock however, oil importing countries tend to adjust faster than oil exporting countries. This can be attributed to the structure of economy of most oil exporting countries which is largely oil-based and therefore, any shock to the variable will have a greater impact on their macro-economy compared to a well-diversified economy of oil importing countries.

Keywords: Energy use, Economic growth, Panel ARDL, Oil exporting countries, Oil importing countries.
JEL Classification: C33, Q43

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1.0 Introduction

A lot of production activities require the use of energy, and efficient use of energy has increased the global economic productivity over the years (OECD (1)). This distinct feature of energy has conferred energy consumption with so much importance as to put governments, policy makers, and researchers on toes towards understanding the degree and direction to which energy consumption affects an economy. With the absence of economic theories explaining distinct direction to which energy consumption and economic growth behave (Mohammadi and Parvaresh (2)), some of the tussles researchers have made was to hypothesize relative connection between energy consumption and economic growth. A number of these hypotheses was proposed by Ozturk (3) and Apergis and Payne (4) who identified four possible relations between energy consumption and economic growth.

One of these hypotheses, the neutrality hypothesis; assumes no relationship between energy consumption and economic growth. In this case, policy implemented for energy consumption will have no impact on economic growth. A second hypothesis is the feedback hypothesis which postulates a bi-directional nexus between energy consumption and economic growth. This hypothesis, of course, gets policy decisions more carefully chosen because policy to conserve energy consumption can also drag economic growth. Thirdly, there is the conservative hypothesis. Conservative hypothesis supposes that there is unidirectional effect coming from economic growth to energy consumption. In this situation, a conservative policy on energy consumption will have no effect on economic growth. Lastly, they hypothesized a growth hypothesis which deduces a unidirectional effect from energy consumption to economic growth. For this hypothesis, the energy policies is intended to reduce the environmental effect, especially a reduction in the energy use, this in return has an effect on consumption, increases output price, lowers consumption and hence economic growth; somewhat a restriction on economic growth.

Although the aforementioned hypotheses have been established for appropriate policy recommendation or decision, the direction of causality between these two variables of interest for individual economy or a group of economies has generated concrete contentions in economic research. This is because, as postulated in growth hypothesis, an economy which solely depends on energy for its revenue or production, any shock in energy price will unfavourably affect the revenue or the economic growth. Thus, knowing the structure of the economy, its dependence on energy, level of growth and possibly, attitude to economic diversification goes a long way in investigating the impact of energy on such economy.

No doubt, literature in this area has been far reached, however, most of this literature have either examined this topic on either developing or developed countries or pooled data on developing and developed; on incomes levels or on whether the country(ies) of study is oil/energy exporting or importing or pooled data on importing and exporting countries. However, what has not been explored, to our knowledge, is the further disaggregation of these samples for comparative analysis.

The purpose of this study is to investigate the relationship between group of oil exporting countries and the group of oil importing countries. Significantly, the study meant to identify and determine the relevance of countries' net oil consumption status on energy consumption – growth nexus. This study follows a multivariate panel framework. It seeks to contribute significantly to the literature by providing empirical evidence on energy consumption – growth nexus based on net oil consumption status of countries (either net oil importer or net oil exporter). In addition, as the sample study cuts across countries with large variance in energy consumption and over large time dimension, this study will deal with the problem of heterogeneity and non-stationarity in panel model by employing panel autoregressive distributive (ARDL) model.

The remainder of the paper is structured as follows: section 2 renders a brief review of the literature; section 3 provides some preliminary data analyses; section 4 presents the models and the underlying formal tests; section 5 discusses the results including robustness tests and section 6 concludes the paper with policy implications.

2.0 Literature Review

The issue of energy-growth nexus has been extensively examined in the literature either on country-specific and panel of countries, continents, regions, oil exporting countries, oil importing countries, OECD, MENA, Gulf cooperation countries, or whether on similar political-features. But there are no literature on the energy use – economic growth nexus on the comparative analysis of oil exporting countries and oil importing countries. Previous studies have examined the energy use – economic growth nexus on the basis of generally accepted hypothesis namely; Neutrality hypothesis, Conservative hypothesis, Growth hypothesis and Feedback hypothesis (see Apergis and Payne, (4); Ozturk, (3)). Also, literature has examined energy use – economic growth nexus using different econometric methodologies, depending on the specific features of the sampled countries, specific objectives as well historical happenings. However, our view is to study the energy consumption – economic growth nexus with the justification of comparing the oil exporting countries and oil importing countries and employing the use of non-stationary heterogeneous panel model.

Critically, there are inconclusive conclusions in the literature on energy use – economic growth nexus. The theoretical argument is on whether the dynamic relationship between energy consumption and economic growth follows the supply-side approach, which treats energy as a factor of production (like capital and labour). This approach suggests that energy use has a direct and positive effect on economic activity that brings about economic growth. There is also the demand-side approach, which treats energy use, in term of economic activity and prices, which assume a direct impact from economic activity through/to energy consumption has a positive effect on economic growth.

In addition, there are inconclusive conclusions on the empirical evidences due to sampled periods and econometric methodology used, as well data structure and countries sampled. Significantly examined and viewed, the literature sequences have four folds (Mehrara (5)). The first is likened to first generation and it involves mainly the use of Vector Autoregression (VAR) method and Granger Causality test (see Kraft and Kraft (6); Yu and Wang (7); Erol and Yu (8)). The second justifies the estimation of long-run and short-run dynamics using the Engle-Granger two-step co-integration procedure technically described as the Error Correction Model (ECM) (see also Nachane, et al, (9); Glasure and Lee (10); Cheng and Lai (11)). Third fold mainly uses the Johansen's Maximum Likelihood procedure (see Ghosh (12); Lee and Chang (13); Soytas and Sari (14)) while the fourth fold considers the panel co-integration and ECM techniques as well assumes either non-stationary or stationary data (Lee (15); Lee and Chang (16); Narayan and Smyth (17); Ciaretta and Zarraga (18); Sadorsky (9)).

Recently, a number of studies have been carried out on energy consumption and economic growth which are as follows; Chali and Mulugeta (20) studied energy consumption and economic growth on 19 developing countries of Common Market for Eastern and Southern Africa (COMESA), where majority of the member countries are Less Developed Countries (LDC) and also among the Highly Indebted Poor Countries (HIPC). The study used panel co-integration and error correction model to test the long-run relationship and short-run causality within the period of 1980 – 2009 using annual data. This study concludes that there is long-run relationship between energy consumption and GDP with the variables in the 1st-order degree of integration and there is a bi-directional long-run and short-run causality between energy consumption and economic growth on the sampled countries under the sampled period. Even though the sampled countries have its similar features, the study did not estimate with Pesaran (2007) that addresses and test for unit root of which the null hypothesis assumes the presence of cross section dependence which addresses the inefficient estimators and correlated regressors, and as a result the source of independence that can leads to standard error biased (see Pesaran (21)). Moreover, some studies were carried out using Panel Co-integration test such as Westerlund (22); Nayaran and Smyth (23) also carried out a study on energy use and output on six middle-east countries, using Panel co-integration test within the period of 1974 – 2002. This study shows that there is bi-directional causality relationship of energy use to output in the long run and there is unidirectional causality between energy use and output in the short-run. In a recent study, Al-Mulali, et al (24) carried out a study on electricity consumption from renewable and non-renewable energy on economic growth in 18 Latin America countries within the period of 1980 – 2010 using panel model framework and granger causality. This study shows that there is long run equilibrium between electricity consumption from renewable and non-renewable energy on economic growth, a bi-directional causality between renewable energy consumption and economic growth and unidirectional causality between non-renewable energy consumption and economic growth under the sample countries.

Significantly, Kahia M. and Ben Aissa M. (25) carried out a study on energy consumption (renewable and non-renewable energy) – economic growth nexus in 13 (thirteen) MENA oil exporting countries within the period of 1980 – 2012, adopting multivariate panel framework, Full Modified OLS and panel Granger causality test. This study concludes that there is unidirectional relationship among non-renewable energy consumption, real gross fixed capital formation, labour force on economic growth in the short-run; bi-directional causality between non-renewable energy and economic growth in the short-run and the long-run; unidirectional causality from economic growth to renewable energy use in the short run and bidirectional causality from economic growth on renewable energy in the long run. The study showed that all the variables are integrated of first order on both cross sectional dependence and cross sectional independence test used. Extensively, Mehrara (5) carried out a study on energy consumption and economic growth on eleven (11) oil exporting countries, using Pedroni's bivariate heterogeneous panel co-integration framework within the period of 1971 – 2002. The study shows that energy consumption does not affect economic growth on the sample countries.

More so, Al-Iriani (26) also studied energy consumption - output nexus on six (6) countries in Gulf Cooperation Countries (GCC), using Pedroni's bivariate heterogeneous panel co-integration framework within the period of 1970 – 2002. The study confirmed that there is a unidirectional causality from output to energy consumption. Sadorsky (19) studied energy use – economic growth nexus on eight (8) middle-east countries, using multivariate heterogeneous panel co-integration framework within the period of 1980 – 2007. This study showed that there is bi-directional causality between energy use and economic growth in the long-run and the short-run. Hassan, et al (27) carried out a study on output – energy consumption nexus on fourteen (14) oil exporting countries, using panel co-integration framework, cross sectional correlation through common-correlated-effects mean group estimator of Pesaran 2006 within the period of 1980 – 2007. This study shows that there is stable relationship between output and energy consumption and bi-directional causality between energy consumption and output in the long run and the short run. Meanwhile, summary of the reviewed literature is presented in Table 1.

INSERT TABLE 1 HERE

3.0 Data and preliminary analyses

This study sets out to understand the nature of the relationship between energy consumption and economic growth of oil exporting and oil importing countries. This was carried out in a comparative analysis form. We adopt annual data over a thirty five years period: from 1980 to 2014. The Gross Domestic Product (GDP) per capita is used as used as proxy for economic growth while Energy use per capita is used as proxy for energy consumption. This study considered five (5) oil exporting countries, namely; Algeria, Australia, Brazil, Iran and Mexico, and six (6) oil importing countries, namely; are France, India, Italy, Japan, Spain and Tunisia. The choice of the selected countries and data scope was determined based on data availability. Data for GDP per capita and Energy use are obtained from World

Development Indicators (WDI). These are obtained in addition to the data for gross fixed capital formation (constant 2005 US$) which appears as a control variable in the model. Another control variable in the model is oil price, proxied by West Texas Intermediate (WTI) and Brent oil price benchmarks. The data for Brent and WTI were obtained from 2017 BP Statistical Review of World Energy.

In Figure 1, the trend in energy consumption and economic growth of oil exporting countries is presented. The charts show that there is clear positive relationship between and economic growth of oil exporting countries, however, the relationship appears to be stronger for Brazil and Mexico than for Algeria, Iran and Australia. Particularly, for Algeria and Iran, the trend suggests that a strong positive relationship between energy consumption and economic growth became noticeable after 1998. This may suggest that a fall in oil price in 1998 stimulate higher industrial productivity and contribution to income in some oil exporting countries.

Also, Figure 2 presents the trend pattern of energy consumption and economic growth for the oil importing countries. From the chart, it was observed that energy consumption co-move with economic growth in all the countries. Our preliminary results show that the co-movement between energy consumption and economic growth is clearer than what we observed in oil exporting countries. However, with observed positive association between energy consumption and economic growth for both oil importing and oil exporting countries, it signifies that the impact of energy consumption on economic growth of oil exporting and oil importing countries could be similar.

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

INSERT TABLE 2 HERE

Table 2 presents the descriptive statistics for energy consumption and economic growth of oil exporting countries and oil importing countries. The number of observation is the product of thirty-five (35) years and five (5) countries for oil exporting countries and the product of thirty-five (35) years and six (6) countries for oil importing countries. From the table, it could be noticed that on the average, oil importing countries consume more energy than oil exporting countries over the period under consideration. This is evident as the mean energy use for oil importing countries is 2250.50 and the mean energy use for oil exporting countries is 2115.83.

More so, the variance between energy consumption and economic growth of both oil exporting countries and oil importing countries is large as evident from the difference between the maximum and the minimum values. This is further corroborated by the standard deviation values. However, with the standard deviation values, it could be confirmed that oil exporting countries the variance in energy consumption and economic growth values is more pronounced for oil exporting countries.

The observed evidence of large variance is an indication that the selected countries are not homogeneous. Apparently, consider the case of Algeria among other net oil exporting countries. The energy consumption level of this country is relatively low; ranging from about 580 compared with other countries whose energy consumption level spread above 2000. Similar evidence can be observed for India and Tunisia among other net oil importing countries. Our choice of heterogenous ARDL model is however justifiable, as it sets to deal with possible heterogeneity among the selected countries.

4.0 The Model and Estimation Procedure

In this study, we modify the neoclassical production function where energy use is introduced as an additional factor of production with capital and labour (see Sahar, et al.,(42)) in order to examine the effect of energy consumption, as an additional factor of production, on the economic activity and economic growth of the countries, among others. This is added to capital and labour to serve as production input and explanatory variables to economic growth. Additionally, we used the same variables to compare the oil exporting countries and oil importing countries and capital and labour are used to control for potential omitted variable bias.

Significantly, the choice of Panel-ARDL framework is justified by the integration properties of the variables used in the model employed. However, in the study we employed robust heterogeneous panel methods namely the Pooled Mean Group (PMG) estimator, Dynamic Fixed Effect (DFE) estimator and the Mean Group (MG) estimators for dynamic non-stationary heterogeneous panels. The appropriateness of this technique is due large T dimensions, as well as small N in our data set. This also allows for stationary test as T is large enough to explain long run. Thus, these estimators employ an autoregressive distributive lag (ARDL) model that allows for the combination of I(0) and I(1) series in the model.

Meanwhile, to confirm that our series are not integrated of order 2, we conduct Panel unit root tests using Levin, Liu and Chu test –LLC; Im, Pesaran and Shin test – IPS; Hadri Lagrange Multiplier test – Hadri; and Pesaran test. These tests have been categorised in the literature into stationary and non-stationary tests, both cross-sectional independence and cross-sectional dependence tests and homogenous and heterogeneous case. Thus, the result for the four tests on the relevant variables are summarised and presented in Table 3.

INSERT TABLE 3 HERE

Expectedly, the integration properties for each of the series vary across the different test but hover around I(0) and I(1). For instance, Hadri test exhibits stationary at levels for all variables for oil exporting and oil importing countries, and IPS and LLC test exhibit unit root at level but stationary at its first difference for the variables.

The results of the four unit root tests are presented in Table 3. We could not reject the null of no unit roots for the entire variables at level using LLC and IPS tests for both groups, that is, oil exporting countries and oil importing countries. However, the null of no unit root were rejected for all the variables in first difference based on LLC and IPS tests. Similarly, the Hadri test in which the null hypothesis implies that the variable is stationary revealed that for all the variables under consideration, in both oil exporting and oil importing countries, we reject the null hypothesis of stationary in level but we could not in first difference. Thus, the conclusion arrived at using Hadri test is the same using LLC and IPS. However, the results are quite different from that of Pesaran test. Under the Pesaran unit root test, we do not reject the null hypothesis of no unit root in the presence of cross sectional dependence both at level and first difference. This suggests the dominance of heterogeneity among the cross-sections which our choice model would effectively capture.

However, the choice of the panel-ARDL framework is further used to examine the integration properties exhibited by the variables of the model.

Thus, the panel-ARDL is specified as below:

$$\Delta y_{it} = \gamma_{0i} + \gamma_{1i} y_{i,t-1} + \gamma_{2i} A_{i,t-1} + \gamma_{3i} K_{i,t-1} + \gamma_{4i} E_{i,t-1} + \sum_{j=1}^{p} \rho_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q1} \beta_{1ij} \Delta A_{i,t-j} + \sum_{j=0}^{q2} \beta_{2ij} \Delta K_{i,t-j} + \sum_{j=0}^{q3} \beta_{3ij} \Delta E_{i,t-j} + \mu_i + \varepsilon_{it} \quad (1)$$

Note: i= 1, 2, … N; t = 1, 2, …, T.

where y is the log of gross domestic product per capita, A is representing log of oil price, K is representing log of physical capital per capita and E is representing log of energy consumption (non-fuel energy) per capita. The terms p, $q1$, $q2$ and $q3$ represent the optimal lag lengths of the respective variables. Also, μ_i captures the country-specific effects and ε_{it} is a normally distributed error term with zero mean and constant variance. For each cross-section, the long run slope (elasticity) coefficient is computed as $\frac{-\gamma_{2i}}{\gamma_{1i}}$, $\frac{-\gamma_{3i}}{\gamma_{1i}}$ and $\frac{-\gamma_{4i}}{\gamma_{1i}}$ for oil price, physical capital and energy consumption, respectively since it is assumed that $\Delta y_{i,t-j} = \Delta A_{i,t-j} = \Delta K_{i,t-j} = \Delta E_{i,t-j} = 0$ in the long run.

Equation (1) may be re-specified in error correction form as follows:

$$\Delta y_{it} = \theta_i \upsilon_{t-1} + \sum_{j=1}^{p} \rho_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q1} \beta_{1ij} \Delta A_{i,t-j} + \sum_{j=0}^{q2} \beta_{2ij} \Delta K_{i,t-j} + \sum_{j=0}^{q2} \beta_{3ij} \Delta E_{i,t-j} + \mu_i + \varepsilon_{it} \qquad (2)$$

where $\upsilon_{t-1} = y_{it-1} - \phi_{0i} - \phi_{1i} A_{i,t-1} - \phi_{2i} K_{i,t-1} - \phi_{3i} E_{i,t-1}$ is the linear error correction term for each unit. The parameter θ_i is the error-correcting speed of adjustment term for each unit which is also equivalent to γ_{1i}. This is expected to be less than unity, negative and significant for long run equilibrium to exist. The long run parameters; ϕ_{0i}, ϕ_{1i}, ϕ_{2i} and ϕ_{3i} in the model are respectively computed as $\frac{-\gamma_{0i}}{\gamma_{1i}}$, $\frac{-\gamma_{2i}}{\gamma_{1i}}$, $\frac{-\gamma_{3i}}{\gamma_{1i}}$ and $\frac{-\gamma_{4i}}{\gamma_{1i}}$.

5.0 Discussion of Results

Table 4 presents the estimation results for the analysis in this study. This comprises of Panel ARDL models estimated with Pooled Mean Group (PMG), Mean Group (MG) and Dynamic Fixed Estimators (DFE). The Hausman test is used to determine the most efficient model under the null. For the analysis on oil exporting countries, the comparison of MG with PMG using the Hausman test shows that the null hypothesis that PMG is preferred is cannot be rejected. This signifies that PMG is better than MG. However, comparing PMG with DFE estimator, it is found that DFE is more efficient than PMG given the insignificant coefficient of the Hausman chi-square distribution. Hence, DFE is adjudged as the most efficient estimator among the heterogenous estimators considered.

Meanwhile, for the analysis on oil importing countries, it is evident from Table 3 that the null hypothesis that PMG is preferred cannot be rejected given the insignificance of the Hausman chi-square coefficient. However, comparing PMG with DFE, it is also confirmed that DFE is preferred than PMG, as the null hypothesis that DFE is more efficient that PMG cannot be rejected. This summarizes that DFE is the most efficient estimator under the estimations for both oil exporting and oil importing countries. The significance of DFE estimator for both oil exporting and oil importing countries presupposes that the degree of heterogeneity among oil exporting and oil importing countries is low. In other words, only error term can be assumed to exhibit heterogeneous feature, while the slope coefficients of short run, long run parameters and the error variances can be assumed to be constant for all the countries.

Hence, concluding from the DFE estimator, some striking results are evident. First, it is found that energy use is positively and significantly related to output growth for both oil importing and oil exporting countries in the long run. This result is also confirmed by MG and PMG. However, with the coefficient of energy use for oil exporting countries (0.881) being greater than that of oil importing countries (0.222), it suggests that energy use has higher positive impact on oil exporting countries than oil importing countries.

More so, this implies that one percent increase in energy use increases economic growth of oil exporting countries in about four times at it will increase the economic growth of oil importing countries, which is an indication that energy use is more efficient in oil exporting countries than oil importing countries. This relative inefficient energy use in oil importing countries may indicate the effect of growth drag, emanating from overdependence on imported oil whose supply and prices are unstable (see [29]). In the short run however, energy use do not have significant impact on economic growth of oil exporting countries, but it still have positive and significant impact on economic growth of oil importing countries.

INSERT TABLE 4 HERE

The second striking result is the impact of oil price on the economic growth of oil importing and oil exporting countries. Also from the DFE results, oil price is found to have short run positive and significant effect on the economic growth of both oil importing and oil exporting countries. However, in the long run, oil price was found to have a negative and significant impact on oil importing countries while its positive and significant impact on oil exporting countries is retained. Hence, it may be concluded that the effect of oil price on growth of oil importing countries is negative in the short run but positive in the long run, while the effect of oil price on economic growth of oil exporting countries in positive both in the short run and long run.

The implication of this result is quite clear as oil constitutes an important cost of production to oil importing countries, hence, it may not be expected to have long run positive impact on the economy of oil importing countries. Definitely, a higher oil price will increase economic costs of production and eventually reduce economic growth in the long run. This may also explain why energy use may drag economic growth of oil importing countries as the result earlier suggested. Meanwhile, higher oil price leading to higher economic growth in oil exporting countries is understandable, as rising oil price will mean higher income to the economy.

The third important result is indicated by the result of the error correction term (ECT). Apparently, the coefficient of ECT is expected less than unity, negative and significant if long run relationship exist among the variables in the model. In this study, as evident is the Table 3, the three estimators suggest that long run cointegration exist among economic growth, energy use, oil price and physical capital, particularly for oil importing countries. However, the assumption failed to hold for PMG under the analysis for oil exporting countries.

Based on the DFE result which was found to be the most efficient model under the null in this analysis, the ECT is found to be less than one, negative and significant for both oil exporting and oil importing countries. This indicates that long run relationship exists between economic growth and energy consumption in both oil exporting and oil importing countries. However, as the coefficient of ECT is higher (in absolute term) for oil importing countries than for oil exporting countries, it suggests it takes longer time for equilibrium to be restored in oil exporting countries than in oil importing countries. In other words, in the case of any temporary shock, oil importing countries adjust faster than oil exporting countries. This may not be unattributed to the structure of economy of most oil exporting countries which is largely oil-based and therefore, any shock to the variable will have a greater impact on their macro-economy compared to a well-diversified economy of oil importing countries.

5.1 Robustness Check

The robustness of the regression results is evaluated in this section. The check for robustness is performed using alternative the oil price proxy (WTI). The results are summarised in Table 5. The results show our analyses are robust to oil price proxies. Evidently, DFE still appears as the most efficient estimator under the null. More so, the conclusion from the effect of energy use on economic growth for oil importing and oil exporting counties still retains, as energy use has positive long run and short run impacts on economic growth, with higher impact for oil exporting countries. More importantly, the ECT result still confirm long run relationship and show that oil importing countries adjust faster to external shock than oil exporting countries. This confirms that our result is robust to the choice of oil price proxy.

INSERT TABLE 5 HERE

6.0 Conclusion and Policy Implication

This study seeks to understand variation in the dynamic relationship between energy consumption on economic growth of oil importing and oil exporting countries. Thus, it contributed to the empirical literature by providing a comparative analysis of the effect of energy use and economic growth of some selected oil importing and oil exporting countries. Also, it accounted for probable stationarity and heterogeneity problems in long panel by adopting non-stationary heterogeneous panel which is a panel version of the AutoRegressive Distributed Lag (ARDL) model by Pesaran and Shin (43).

We consider three estimators of non-stationary heterogeneous panel, namely; Mean Group (MG), Pooled Mean Group (PMG) and Dynamic Fixed Effect (DFE). Using Hausman test, we find that DFE is the most efficient under the null. This implies that the degree of heterogeneity among oil exporting and oil importing countries is low. In other words, only error term can be assumed to exhibit heterogeneous feature, while the slope coefficients of short run, long run parameters and the error variances can be assumed to be constant for all the countries.

Our result shows that energy use is positively and significantly related to output growth for both oil importing and oil exporting countries in the long run. This result is also confirmed by MG and PMG. However, as the coefficient of energy use for oil exporting countries is greater than that of oil importing countries, it suggests that energy use has higher positive impact on oil exporting countries than oil importing countries. Also, the result shows that the effect of oil price on growth of oil importing countries is negative in the short run but positive in the long run, while the effect of oil price on economic growth of oil exporting countries in positive both in the short run and long run.

Lastly, it is found that in the presence of shocks, oil importing countries tend to adjust faster than oil exporting countries given its relatively higher coefficient of error correction term (ECT). This may not be unattributed to the structure of economy of most oil exporting countries which is largely oil-based and therefore, any shock to the variable will have a greater impact on their macro-economy compared to a well-diversified economy of oil importing countries.

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Table 1: Summary of Literature review

Authors	Period	Countries	Theoretical framework	Methodology	Findings
Eyup DOGAN (28)	1971-2011	Sub-Saharan Africa		Granger Causality	One way causality from energy use to economic growth
Omer Esen and Metin Bayrak(29)	1990-2012	75-Net energy importing countries		Long panel	Positive and significant relationship between energy consumption and economic growth.
Kais Saidi and Sami Hammami(30)	1974-2011	Tunisia	Neoclassical growth theory	Error Correction Model and Granger Causality	Bidirectional Causality between energy consumption and economic growth.
Hassan Mohammadi and Shahrokh Parvaresh (2)	1980-2007	14 oil exporting countries		Linear heterogeous panel regression model	Stable relationship between energy consumption and economic growth
Shahbaz, Zeshan and Afza (31)	1972-2011	Pakistan	Cobb Douglas production Function	ARDL	Positive relationship between energy consumption and growth
Kahia et al (25)	1980-2012	11 MENA Net Oil importing countries		Panel Error correction model	Positive and significant relationship between energy use and economic growth.
Aqeel and Sabihuddin Butt (32)		Pakistan		Hsiao's Granger Causality	Economic growth increases energy consumption
Behera (33)	1970-2011	India		Autoregression VAR	Bidirectional influence between electricity consumption and economic growth
Eggoh et al (34)	1970-2006	21 African countries		Panel error correction Model	long-run equilibrium relationship between energy consumption and economic growth
Yazdan and Hossein (35)	1980-2010	Iran		ARDL	In the short-run, the Granger causality runs from economic growth to energy consumption
Mohammadi and	2003-	13 OPEC		Panel	Stable long run

Mohammadi (36)	2011	countries		Cointegration	relationship between economic growth and value of petroleum exports
Mahrara (5)	1971-2002	11 oil exporting countries			Unidirectional relationship running from economic growth to energy use
Yuan et al (37)	1963-2005	China	Neoclassical growth theory	Error correction model	Existence of long-run cointegration among output, labour, capital and energy use.
Farhani and Ben Rejeb (38)	1971-2008	95 countries		Panel Cointegration	Bidirectional causality in lower-middle and upper - middle income countries
Arfaoui (39)	1975-2011	8 MENA countries		Granger Causality	One way causality between economic growth and energy consumption.
Kashai et al (40)	1980-2007	Sub-Saharan African countries		Panel Cointegration	Bidirectional causality.
Alaali, Roberts and Taylor(41)	1981-2009	130 countries	Neoclassical growth theory	GMM	Energy consumption is found to support economic growth

Source: Compiled by the authors

Table 2: Descriptive statistics

Statistics	**Oil exporting countries**		**Oil importing countries**	
	Energy Use	GDP per capital ($)	Energy Use	GDP per capital ($)
Mean	2115.83	13391.15	2250.50	26276.86
Minimum	579.45	3164.89	10.06	389.93
Maximum	5964.67	54394.34	4301.74	46466.1
Std. Dev.	1652.92	14641.25	1455.61	13844.79
Observation	175	175	210	210

Source: Compiled by the authors

Table 3: Unit root results

Variables	Oil exporting countries				Oil importing countries			
	LLC	IPS	Hadri	Pesaran	LLC	IPS	Hadri	Pesaran
Y	0.6257	4.1728	39.7239***	-0.914	-0.612	0.785	51.607***	2.096
K	0.9781	2.799	41.2896***	1.929	-0.399	1.959	49.033***	0.184
E	0.7829	2.0468	45.4168***	1.162	-7.909	0.51	50.732***	3.582
OP	2.5745	2.9540***	28.3254***		2.82	3.236	31.029***	
First Differences								
ΔY	-4.2343***	-6.0649***	1.3070*	-1.919**	-4.266***	-5.477***	7.486***	0.921
ΔK	-6.8257***	-6.6981***	0.0624	-0.804	-3.906***	-6.007***	1.689**	1.843
ΔE	-6.8519***	-7.8646***	-0.6322	-0.31	-2.478**	-7.056***	5.614***	0.169
ΔOP	-7.2194***	-7.5909***	2.3053**		-7.909***	-8.315***	2.525**	

Note: Y indicates GDP per capita; K is capital; E is energy use; OP is Brent oil price and Δ is difference operator. Also, ***,**, and * indicate significance at 1%, 5% and 10% level respectively.

Table 4: Panel regression results with Brent

	Oil exporting countries			Oil importing countries		
	MG	PMG	DFE	MG	PMG	DFE
Constant	0.362	0.410	0.130	3.038	0.014	1.355*
	(0.353)	(0.256)	(0.094)	(2.819)	(0.177)	(0.769)
K	-0.081	0.198***	0.062	0.273**	0.151	0.217***
	(0.286)	(0.066)	(0.068)	(0.112)	(0.424)	(0.027)
E	1.972	0.286**	0.881***	0.256**	1.153	0.222***
	(1.597)	(0.115)	(0.163)	(0.109)	(0.812)	(0.052)
OP	0.044	0.041	0.018*	-0.021	0.071	-0.023***
	(0.036)	(0.031)	(0.010)	(0.013)	(0.128)	(0.008)
ΔK	0.130***	0.199***	0.179***	0.134***	0.173***	0.152***

	(0.030)	(0.023)	(0.031)	(0.032)	(0.019)	(0.037)
ΔE	-0.011	0.037	0.026	0.045	0.200***	0.124**
	(0.080)	(0.049)	(0.044)	(0.055)	(0.037)	(0.052)
ΔOP	0.015*	0.032***	0.024**	0.010***	0.015***	0.017**
	(0.009)	(0.009)	(0.010)	(0.003)	(0.005)	(0.008)
ECT(-1)	-0.326***	0.158***	-0.140**	-0.375***	-0.023	-0.240***
	(0.115)	(0.041)	(0.071)	(0.127)	(0.014)	(0.077)
Hausman test						
X2 (Prob)						
MG vs. PMG		5.25			0.47	
		(0.1543)			(0.9244)	
PMG vs. DFE		0.00			0.00	
		(1.000)			(1.000)	

Notes: Standard errors in parenthesis. *** , ** , and * indicate significance at 1%, 5% and 10% level of significance, respectively. MG implies Mean Group; PMG implies Pooled Mean Group and DFE indicates Dynamic Fixed Effect estimator. Also, ECT denotes Error Correction Term, K, E, and OP represent long run estimates of physical capital, energy use and oil price, respectively, while ΔK, ΔE and ΔOP indicate short run estimates of physical capital, energy use and oil price, respectively.

Table 5: Panel regression results with WTI

Variables	**Oil exporting countries**			**Oil importing countries**		
	MG	PMG	DFE	MG	PMG	DFE
Constant	0.390	0.885***	-0.196	3.109	0.007	3.364
	(0.321)	(0.329)	(0.191)	(2.864)	(0.177)	(2.939)
K	0.039	0.074	0.195***	0.265**	0.163	-0.003***
	(0.169)	(0.051)	(0.063)	(0.107)	(0.426)	(0.032)
E	7.706	0.271**	0.666***	0.270**	1.150	0.646***
	(7.324)	(0.129)	(0.189)	(0.107)	(0.817)	(0.078)
OP	-0.251	0.059	0.128***	-0.026	0.076	
	(0.277)	(0.037)	(0.029)	(0.014)	(0.142)	
ΔK	0.118***	-0.003***	0.154***	0.134***	0.173***	0.196***
	(0.038)	(0.007)	(0.047)	(0.032)	(0.019)	(0.028)
ΔE	-0.003	0.129**	0.055	0.039	0.197***	0.082**
	(0.080)	(0.64)	(0.103)	(0.055)	(0.037)	(0.059)
ΔOP	0.019*	0.030***	0.013**	0.010***	0.015***	
	(0.006)	(0.012)	(0.008)	(0.003)	(0.005)	
ECT(-1)	-0.320***	0.180***	-0.130**	-0.375***	-0.023	-0.224***
	(0.108)	(0.043)	(0.132)	(0.129)	(0.014)	(0.146)
Hausman test						
X2 (Prob)						
MG vs. PMG	7.01			17.30		
	(0.0717)			(0.0002)		
MG vs. DFE	0.00			0.00		
	(1.00)			(1.000)		

Notes: Standard errors in parenthesis. *** , ** , and * indicate significance at 1%, 5% and 10% level of significance, respectively. MG implies Mean Group; PMG implies Pooled Mean Group and DFE indicates Dynamic Fixed Effect estimator. Also, ECT denotes Error Correction Term, K, E, and OP represent long run estimates of physical capital, energy use and oil price, respectively, while ΔK, ΔE and ΔOP indicate short run estimates of physical capital, energy use and oil price, respectively.

Figure 1: Energy consumption and Economic growth for selected Oil exporting countries

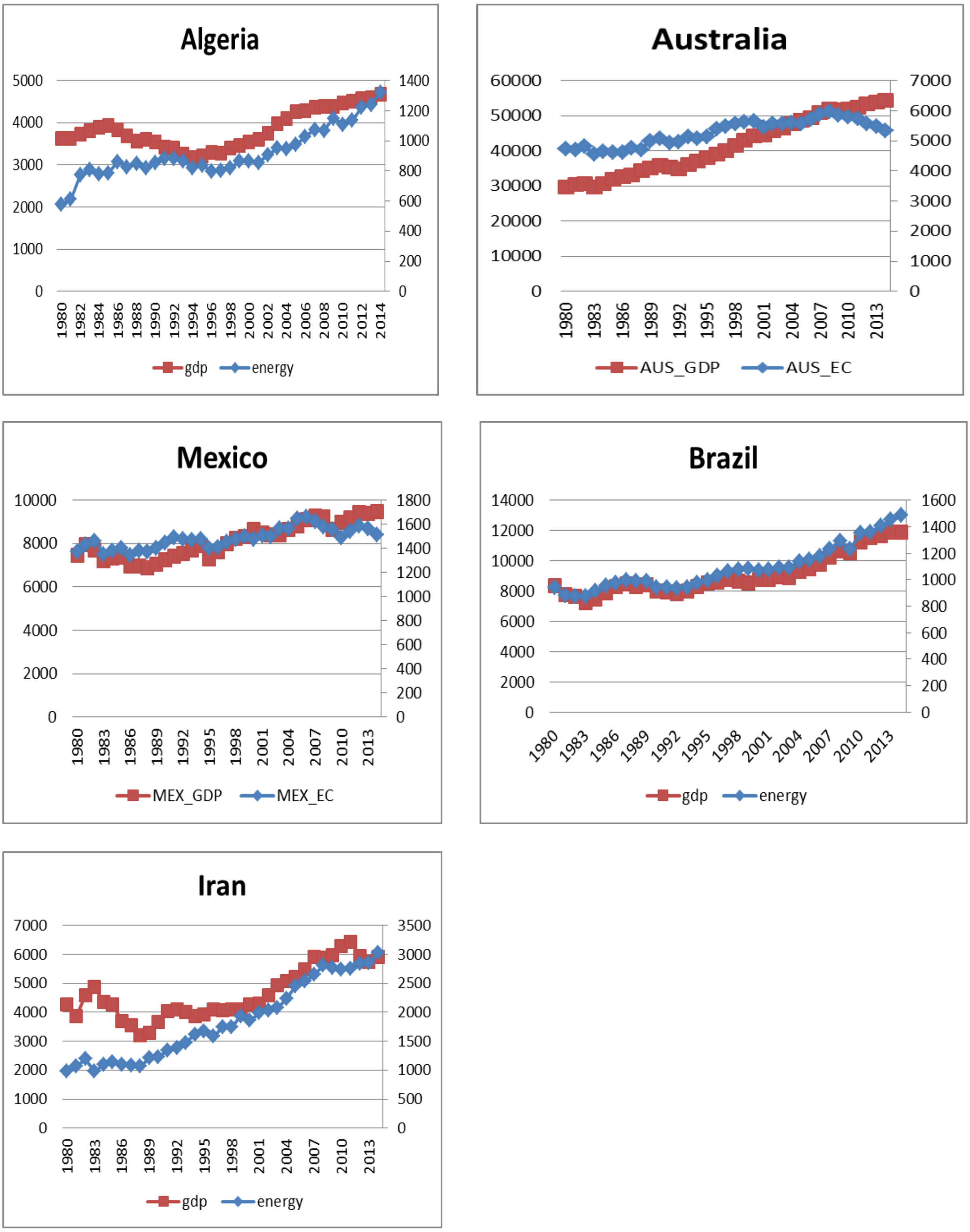
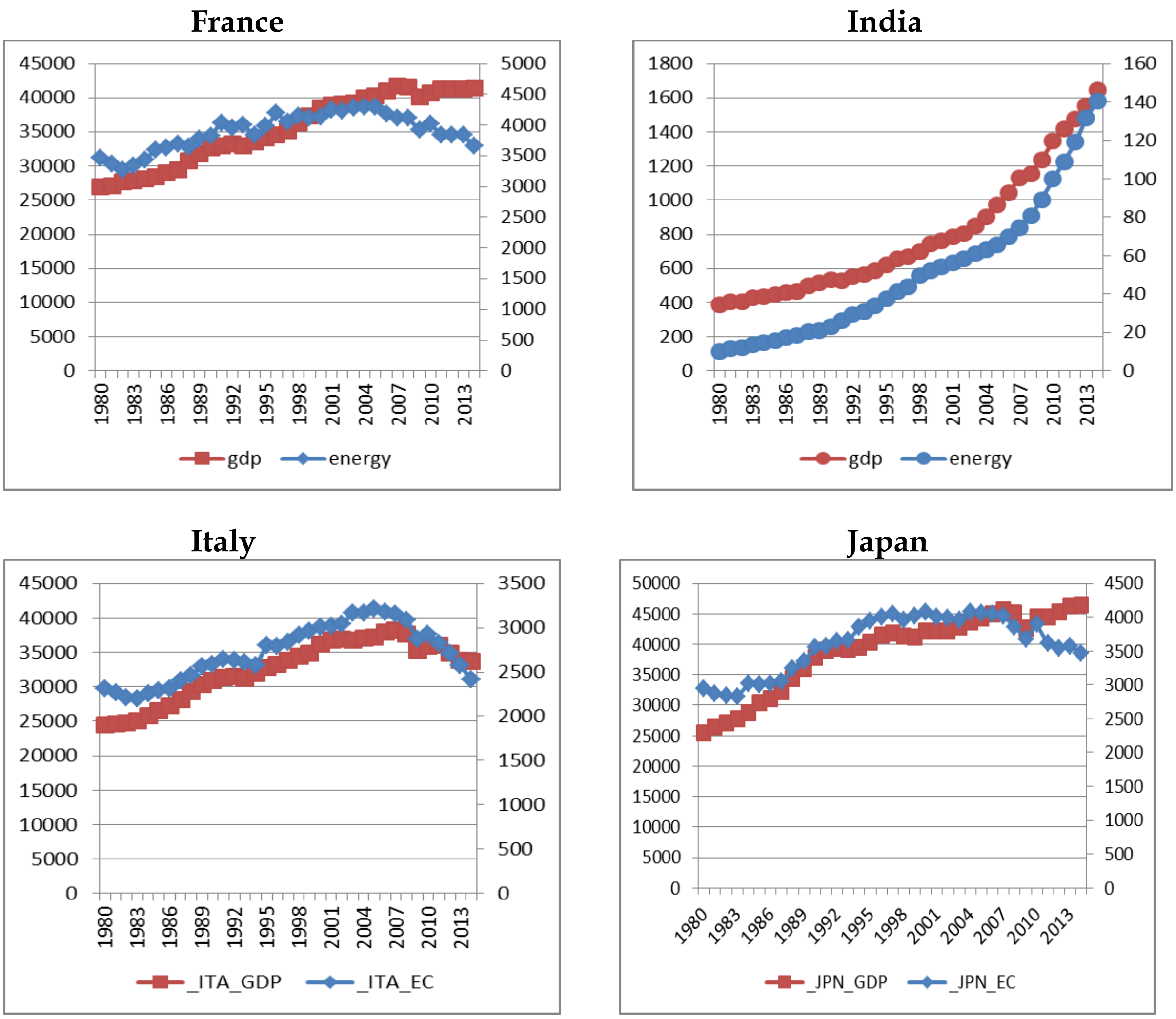
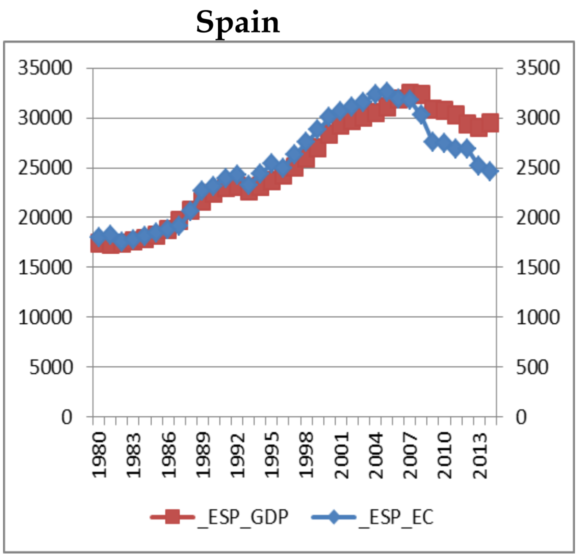
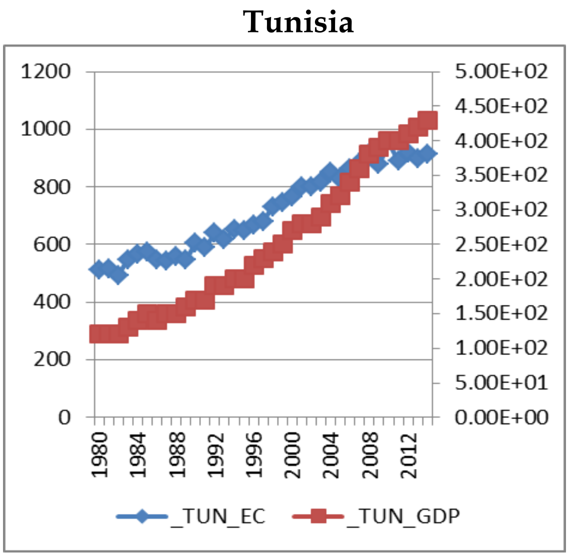


Figure 2: Energy consumption and Economic growth for selected Oil importing countries




Spain
35000
30000
25000
20000
15000
10000
5000
0
3500
3000
2500
2000
1500
1000
500
0
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
_ESP_GDP
_ESP_EC


Tunisia
1200
1000
800
600
400
200
0
5.00E+02
4.50E+02
4.00E+02
3.50E+02
3.00E+02
2.50E+02
2.00E+02
1.50E+02
1.00E+02
5.00E+01
0.00E+00
1980
1984
1988
1992
1996
2000
2004
2008
2012
_TUN_EC
_TUN_GDP