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## Article

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## A Panel Dynamic Analysis on Energy Consumption, Energy Prices and Economic Growth in Next 11 Countries

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### ABSTRACT

This study empirically examines the impacts of energy consumption and energy prices on economic growth for three data sets of panel groups of Next 11 countries within a multivariate panel framework over the period 1990-2013. For the entire panel group of Next 11 countries, it is obtained from the results of panel Autoregressive Distributed Lag estimation approach that, energy consumption has a positive and energy prices have a negative impact on economic growth, both in the long-run and short-run; and a unidirectional causal linkage between economic growth and energy consumption is confirmed by the results of panel causality tests. For the 6 of Next 11 net oil-importing countries panel group, it is found from panel Dynamic Ordinary Least Squares method that, economic growth is negatively influenced by both energy consumption and energy prices. The results of panel Autoregressive Distributed Lag estimation approach for the 5 of Next 11 net oil-exporting countries panel group portrays that, in the long-run, energy consumption negatively affects economic growth and energy prices positively influence economic growth, while in the short-run, economic growth is negatively affected by both energy consumption and energy prices.

**Keywords:** Energy Consumption; Energy Prices; Economic Growth; Next 11 Countries

**JEL Classifications:** C33, C51, Q4, Q43

### 1. INTRODUCTION

Energy has become a salient driver of any country's economic growth. It contains a strategic impact for any country's economic growth. Energy consumption and economic growth are considered to be highly correlated. Higher economic growth requires more energy consumption. Energy is an indispensable element in aggregated production function and in boosting economic growth level of any country. The energy consumption and economic growth relationship is largely studied in previous literatures (Apergis and Payne; 2009a; 2009b; 2010a; 2010b; Ozturk, 2010; Bouoiyour et al., 2014; Murshed, 2020a). Ucan et al. (2014); Rafindadi and Ozturk (2015) and Rafindadi and Ozturk (2016)

and Murshed (2018) indicated that, high energy consumption is one of the basic indicators of economic growth level achieved by a country. GDP of a nation and industrial growth are positively enhanced by energy consumption (Rahman and Majumder, 2020). Energy prices and energy consumption are considered as important determinants of global economic performance as they play a substantial role in determining real GDP. A persistent rise in energy prices have been secured a great concern from economists since the stress of oil price in 1970s. From preceding two decades, causality between energy price and economic growth has been examined. Most empirical studies concerned with influence of frequently changing crude oil prices on economic growth are conducted for developed countries because of their data availability but some empirical works have been done in very recent years to examine

impacts of energy consumption and changes in crude oil price on growth of economy for the countries those are in developing phase. But most of the empirical findings are somewhat conflicting regarding this topic. Several authors stated that impact of oil price on macroeconomic indicators is temporary in the short-run, while others said that rising oil price may contain negative impact on economic growth and development around the world. Energy price fluctuations hurts both energy exporting and importing nations and may cause higher consumer price inflation (Murshed and Tanha, 2020).

Next 11 countries- Mexico, Bangladesh, Indonesia, Egypt, South Korea, Turkey, Iran, Nigeria, Philippines, Pakistan and Vietnam-identified by Goldman Sachs on December 12, 2005 because of their growth potential, investment friendly environment, macroeconomic stability, trade liberalization and political stability. Collectively now N-11 comprises total 1.52 billion people. Indonesia has the largest population while South Korea has the smallest population among these 11 countries as of January 2020. These eleven countries varied geographically along with different levels of wealth and extreme social and economic diversity. Because of this diversity some countries are expected to grow rapidly while other countries are expected to grow slowly and this diversity within the group creating difficulty to predict their economic growth. The “Next Eleven” are projected to collectively overtake the EU-27 in global power by 2030. Among 11 countries included in Next-11 some countries are oil exporting country and some countries are oil importing country. Some oil importing countries also export oil and some export more oil than they import. Furthermore, some oil exporting countries also import oil and some import more than they export. Considering these facts, this study listed 6 countries; Bangladesh, Pakistan, South Korea, Turkey, Indonesia and Philippines, as net oil-importing countries and 5 countries; Nigeria, Vietnam, Mexico, Iran and Egypt, as net oil-exporting countries. This study gathered information from CIA World Fact book, where the rankings are based data available up to January 1, 2019. Which country’s total oil imports in barrels per day exceeds its total oil exports is ranked as net oil importing country and which country’s total oil exports in barrels per day exceeds its total oil imports is ranked as net oil exporting country in this study.

N-11’s current nominal GDP is almost \$6.5 trillion. The size of economy of N-11 is more than twice the total size of India’s while about half the size of China’s. It has been forecasted that these eleven economies will be the most powerful economies of world within 2030. These countries have potential emerging economies after BRICs and could be a vital source of investment over next two decades. Among eleven countries Turkey, Indonesia, Mexico, Philippines and South Korea are found in emerging market investment indices. With an estimated GDP of about \$US 743.71 billion, Turkey ranked 19<sup>th</sup> and South Korea ranked 12<sup>th</sup> with an estimated amount of GDP \$US 1,269.53 billion among 20 countries with largest GDP (Statista, 2020). O’Neill et al. (2005) predicted that, Turkey, South Korea and Mexico could overtake many G7 countries. In 2019, N-11’s contribution in World GDP (US\$ million) is 8% and it is expected to increase in the next few decades. Wilson and Stupnytska (2007) stated that, only Mexico, Turkey and South Korea have a strong prospect of seizing to

developed country income level over next few decades while other N-11 countries could still face huge accelerations to income levels. Vietnam could see more than fivefold increment in income level in the next 25 years.

N-11 countries are accompanied by increased energy consumption with growing economies and expanding industrialization. These 11 countries are responsible for large portion of energy consumption of world. Each of the country’s share has risen in world energy consumption since 1990 (Lawson et al., 2007). In 2014, world’s consumption was around 374.11 Quadrillion BTU and N-11’s consumption was around 54.092 Quadrillion BTU which is accounted for about 13% of entire world’s energy consumption. According to Global Energy Statistical Yearbook (2019), South Korea consumed 307 Metric ton oil equivalent energy in 2019 which is 6<sup>th</sup> highest amount in the whole world, Iran consumed 265 Metric ton oil equivalent energy and Indonesia consumed 251 Metric ton oil equivalent energy.

This study mainly tended to ascertain the impacts of energy consumption and energy prices on economic growth of Next 11 countries; and the particular objectives are to examine the impacts on Next 11 net oil-importing countries and Next 11 net oil-exporting countries. This study may help to know that how much energy role is important for economic growth of N-11 countries. Obtained results from this study also may assist in designing policies concerned with energy development and the policies concerned with conservation of sustainable and long-term economic development of N-11 countries.

The rest of the paper is organized as follows. Theoretical framework and findings of relevant literatures are presented in Section 2. Section 3 describes the empirical model and data. Empirical methodology is discussed in Section 4. Section 5 discusses empirical results. Section 6 provides conclusions and recommendations.

## 2. LITERATURE REVIEW

Literatures in this area started to enlarge promptly after Kraft and Kraft’s seminal work in 1978. This study tried to render a brief inspection of previous theoretical and empirical studies relevant to this topic.

### 2.1. Theoretical Framework

Energy sector contains a vital role to shape global economic development and growth. Glasure and Lee (1997) said that, energy acts as a vital player in economic development. Some other studies concluded, consumption of energy has a favorable influence on economic growth; on other side, some studies have revealed, consumption of energy may contain negative effect on economic growth.

Production is one of the main determinants of any country’s economic growth. It is well known that production (Y) function is composed of Capital (K) and Labor (L):

$$Y=f(K,L)$$

Without energy resources, production is impossible. To show the nexus and causal direction between energy consumption and economic growth, following four key hypotheses are emerged and tested in previous literatures (Omri, 2014; Ozturk, 2010, Shahbaz et al., 2015):

- i. Growth Hypothesis is valid when a unidirectional causal linkage is found between energy consumption and economic growth. This hypothesis reveals that energy conservation policies in favor of reducing energy consumption will have a negative impact on economic growth.
- ii. Conservation hypothesis is valid if it is found that a unidirectional causality is stemming from economic growth to energy consumption. According to this hypothesis, energy conservation policies those may cause in reducing energy consumption will not negatively affect economic growth.
- iii. Feedback hypothesis is supported if bidirectional causal association is confirmed between energy consumption and economic growth. According to this hypothesis, energy conservation policies formulated to prevent energy consumption will reduce economic growth and the negative result of this reduction will be reflected to energy consumption.
- iv. Neutrality hypothesis is valid if no causal relationship exists between energy consumption and economic growth. This hypothesis reveals that energy conservation policies formulated for reducing energy consumption will not have any effect on economic growth.

The energy consumption and economic growth relationship has been studied in two approaches called supply-side and demand-side. The supply-side approach focuses in studying the energy consumption contribution in economic activities using traditional production function framework and the demand-side approach focuses on studying the energy consumption, economic growth

and energy prices relationship widely known as tri-variate energy demand model (Lee, 2005).

The Next 11 countries seem to have a high growth potential, even they have the potential to become the world's largest economies of the 21<sup>st</sup> Century (Kenton, 2018). Rising economic growth in the N-11 countries is creating new consumer markets which may contribute to growth process. These economies are participating in world trade and investment activities and increased investment imply higher capital stock which further leads to higher economic growth. N-11 group is facing rapid economic growth because of a greater degree of trade openness at the international level. By consuming more energy N-11 is capturing high economic growth and contributing in global GDP but high energy prices or oil prices creating barriers to its growth path. Efficient and active labour forces are asset for any country and their contribution in economic growth process is noteworthy. So, it can be said in a nutshell, energy consumption, trade openness, capital stock or formation and labour force are expected to have positive impacts and energy prices have negative impact on economic growth for Next 11 countries. The theoretically associative model is depicted in Figure 1.

Effects of oil price change are not symmetric among countries. Ghalayini (2011) observed that fluctuations in oil price do not possess the similar outcome among various countries. The effects depend on the category to which each country belongs (net exporting or net importing). Nexus between oil price and economic growth in case of net oil-importing countries and net oil-exporting countries are depicted in Figure 2. When a country is net importer of oil, rise in oil price may negatively affects their economic growth by lowering consumption. For a net oil-exporting country, a rise in oil price positively affects their economic growth by higher earnings from oil exports. Consequently, wealth is relocating to oil exporting countries

Figure 1: Theoretical framework

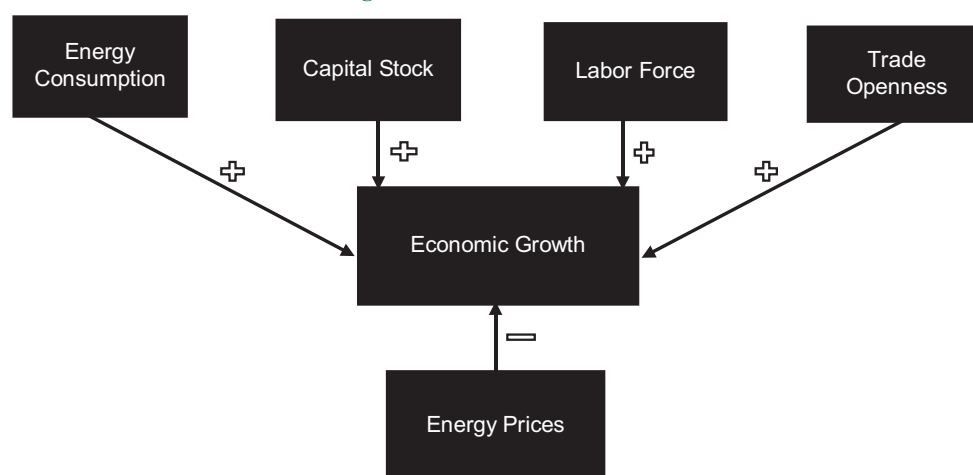
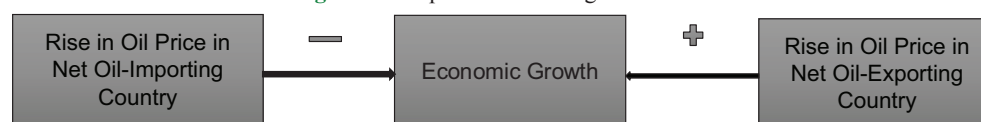


Figure 2: Oil price-economic growth nexus





from oil importing countries (Birol, 2004). Oriakhi and Osaze (2013) mentioned that, oil price changes can both facilitate and incapacitate the economy simultaneously by direct and indirect effects. Therefore, an affirmative contingent outcome for the rise in earnings of oil exporting countries facilitating oil importing countries to export more commodities to these relevant countries, which indirectly lessening their net loss.

## 2.2. Empirical Findings

There is a huge amount of empirical research work done on this topic. Kousar et al. (2019) investigated the impacts of energy consumption, energy prices on economic growth in Pakistan for the period 1971-2014. The study applied Vector Error Correction Model (VECM) for Granger causality test. Unidirectional causal linkage is found between economic growth and energy consumption both in the short-run and long-run. Unidirectional causality is confirmed between energy consumption and energy prices in the short-run and bidirectional causality is stemming from energy consumption and energy prices in long-run is found.

Ogboru et al. (2017) empirically examined oil price changes' impact on economic growth of Nigeria by taking study period 1986-2015. The study used Vector Error Correction Model (VECM) for Granger causality test and found that, a unidirectional causal relationship is present between crude oil prices and Nigeria's growth rate of GDP.

Shahbaz et al. (2016) detected the causal relationships among CO<sub>2</sub> emissions, energy consumption and energy growth in Next 11 countries for the period 1972-2013 by using traditional time-constant and time-varying Granger causality approaches. The study found that, economic growth leads to energy consumption in Bangladesh, Turkey, South Korea and Vietnam; and energy consumption leads to economic growth in the Philippines. But no causal link is found between energy consumption and economic growth in Iran, Nigeria and Mexico.

Yildirim et al. (2014) studied the relationship between energy consumption and economic growth in case of Next-11 countries by applying bootstrapped auto regressive metric and Toda–Yamamoto (T-Y) causality approaches. The study found one-way causality is stemming from energy consumption to economic growth in Turkey by using AR metric approach which supports growth hypothesis. No causal nexus is found between energy consumption and economic growth for Bangladesh, Iran and Mexico using AR metric approach. On the contrary, one-way causality from energy consumption to economic growth for Bangladesh and Iran; and a unidirectional causality from economic growth to energy consumption for Mexico is found by T-Y approach. Furthermore, the study found a causal linkage between energy consumption and economic growth for Pakistan and a bidirectional causality from energy consumption to economic growth for Turkey, by applying T-Y causality approach.

Chung (2014) investigated the impacts of international oil price changes on Vietnam's economy for the period 1996-2007 by employing input-output model. The study found the impact of international oil price changes is much higher in the long-run than in the short-run in Vietnam.

Another study was conducted by Alley et al. (2014) to examine the influence of oil price shock on Nigerian economy for the period 1981-2012. The study used General Methods of Moment (GMM) to examine the impact. The empirical results of the study show that, oil price shocks affect economic growth of Nigeria insignificantly.

According to Jawad (2013), oil price volatility had an insignificant impact on GDP of Pakistan during 1973-2011, which was showed by the results of linear regression analysis. Some other relevant empirical studies are summarized in Table 1.

Most of the existing studies in the energy-growth literature which have been mainly focused on Next 11 member countries separately but studies on this topic incorporating all the 11

**Table 1: Summary of some relevant literatures**

Authors	Period	Scope/Country	Method	Result
Dabachi et al. (2020)	1970-2018	African OPEC Countries	Simultaneous Equations Models	Bidirectional causal relationship exists between energy consumption and economic growth; and energy prices and economic growth
Wasti and Zaidi (2020)	1971-2017	Kuwait	ARDL Model	Energy consumption accelerates economic growth
Murad et al. (2018)	1970-2012	Denmark	ARDL Model	Energy prices have a significant negative influence on energy consumption
Mothana and Michelle (2018)	2000-2017	Selected oil exporting countries	Panel REM	Oil price volatility negatively affects economic growth of these selected oil exporting countries
Osigwe and Arawomo (2015)	1970-2012	Nigeria	ECM	Bidirectional causal association is present between energy consumption and economic growth
Oriakhi and Osaze (2013)	1970-2010	Nigeria	VAR Model	Fluctuations in oil price impacts economic growth and government expenditure
Gökçe (2013)	1987.Q1-2011.Q1	Turkey	Structural VAR Model	Structural shock in real crude oil price decreased quarterly economic growth
Nondo et al. (2012)	1980-2005	19 COMESA countries	Panel ECM	Long-run bidirectional causal relationship exists between energy consumption and economic growth
Lee and Chang (2007)	1971-2002	16 Asian countries	Panel ECM	Long-run positive co-integration is found between energy consumption and real GDP
Hadian and Parsa (2006)	1961-2005	Iran	VECM	Oil price volatility insignificantly affects macroeconomic variables

Source: Authors' own compilations

countries included in the term Next 11 are almost very little. Most of the previous studies fall into the trap of omitted variable(s) as they only scrutinized the nexus of energy-growth in a bi-variate framework but didn't incorporate other important variables which are also important determiner of economic growth. This study tried to fill these gaps exist in previous literatures. This study may be first attempt to apply panel approach for evaluating interrelationships among energy consumption, energy prices and economic growth of N-11 group. This study also analyzed the net oil importing and net oil exporting Next 11 member countries separately by applying panel approach.

### 3. DATA AND EMPIRICAL MODEL SPECIFICATION

#### 3.1. Data

Three data sets of panel groups of Next 11 countries are used for this paper. The first data set consists of balanced annual data of 264 observations for 11 countries included in Next 11. The second data set consists of balanced annual data of 144 observations for 6 N-11 net oil-importing countries. Third data set consists of balanced annual data of 120 observations for 5 N-11 net oil-exporting countries. For the three data sets the study period spans from 1990 to 2013. Choosing this starting and ending period is constrained by the availability of necessary data of variables. Most of the data are collected from various reliable secondary sources such as World Development Indicators (WDI) databases prepared by World Bank. (2019), International Energy Agency (IEA) and BP Statistical Review of World Energy, 2019, 68<sup>th</sup> edition. Some data are collected from journals, articles and unpublished thesis.

#### 3.2. Measurement of Variables

The dependent variable is GDP (constant 2010 US\$) as proxy to measure economic growth. Explanatory variables are energy prices, which is measured by proxy, Spot Crude Oil Prices (Brent US dollars per barrel) and energy consumption, which is measured by a proxy, Energy Use (Kg of oil equivalent per capita). To overcome omitted variables bias problem, the study used Gross Capital Formation (% of GDP) as proxy to measure Capital Stock; Labour Force, total as proxy to measure Labour Force and Trade (% of GDP) as proxy to measure Trade Openness as control variables. All the variables are used in natural logarithmic form to attain more accurate empirical results. Variables, proxies, units of measurement, notations and elaborations of variables are presented in Table 2.

**Table 2: Variable description**

Variable	Proxies	Notation	Elaborations
Economic growth	GDP (constant 2010 US\$)	LGDP	Natural logarithm of GDP in the selected countries
Energy consumption	Energy use (Kg of oil equivalent per capita)	LEC	Natural logarithm of energy consumption in the selected countries
Energy prices	Spot crude oil prices (Brent US dollars per barrel)	LEP	Natural logarithm of energy prices in the selected countries
Capital stock	Gross capital formation (% of GDP)	LK	Natural logarithm of capital stock in the selected countries
Labour force	Labour force, total	LLF	Natural logarithm of labour force in the selected countries
Trade openness	Trade (% of GDP)	LTO	Natural logarithm of trade openness in the selected countries

Source: Authors' own compilations

#### 3.3. Empirical Model Specification

This study tried to establish relationships among Economic Growth, Energy Consumption, Energy Prices, Capital Stock, Labour Force and Trade Openness for N-11 countries together and then separately for 6 net oil-importing N-11 member countries and 5 net oil-exporting N-11 member countries. Then the functional form of the relations among the variables of the linear model is the following:

$$GDP_{it} = f(EC_{it}, EP_{it}, K_{it}, LF_{it}, TO_{it})$$

By using the natural logarithmic form,

Econometric form of the model for entire Next 11 countries:

$$LGDP_{it} = \beta_1 + \beta_2 LEC_{it} + \beta_3 LEP_{it} + \beta_4 LK_{it} + \beta_5 LLF_{it} + \beta_6 LTO_{it} + \mu_{it} \quad (1)$$

Econometric form of the model for 6 Next 11 net oil-importing countries:

$$LGDP_{it} = \beta_1 + \beta_2 LEC_{it} + \beta_3 LEP_{it} + \beta_4 LK_{it} + \beta_5 LLF_{it} + \beta_6 LTO_{it} + \mu_{it} \quad (2)$$

Econometric form of the model for 5 Next 11 net oil-exporting countries:

$$LGDP_{it} = \beta_1 + \beta_2 LEC_{it} + \beta_3 LEP_{it} + \beta_4 LK_{it} + \beta_5 LLF_{it} + \beta_6 LTO_{it} + \mu_{it} \quad (3)$$

The notations of relevant variables used in these equations are explained in Table 2.

Where,

$i = 1, \dots, n$  are panel members where,  $n = 11$  countries, in case of equation (1)

$i = 1, \dots, n$  are panel members where,  $n = 6$  countries, in case of equation (2)

$i = 1, \dots, n$  are panel members where,  $n = 5$  countries, in case of equation (3)

$t = 1, \dots, t$  are time periods where,  $t = 1990$  to  $2013$

$\beta_1 - \beta_6$  = All are the coefficients to be estimated

$\mu_{it}$  = Combined time series and cross-section error term where,  $\mu_{it} \sim N(0, \sigma^2)$ .

## 4. EMPIRICAL METHODOLOGY

Econometric analyses have been done by software EViews 9. This study employed various Panel data based econometric techniques for empirical analyses. Panel unit root tests have been applied separately for the three equations, to test the level of stationarity of the variables. Optimal lag has been selected separately for the three equations by satisfying necessary criteria. Then the study applied co-integration test for the equation for the 6 N-11 net oil importing countries. The study has used Panel ARDL estimation technique to estimate the parameters of the equation for entire Next 11 countries and for checking the robustness of panel ARDL technique's results, panel FMOLS and panel DOLS estimation approaches have been also applied. Then the study has adopted Panel DOLS to estimate the parameters of the equation for 6 net oil importing N-11 member countries and Panel ARDL to estimate the parameters of the equation for 5 net oil exporting N-11 member countries. To identify the causal relationship and causality direction, pairwise Granger causality tests have been done for the three data sets.

### 4.1. Panel Unit Root Tests

Panel unit root tests are used for checking whether the variables are stationary or nonstationary; or whether they are integrated to same order or mixed order (Murshed et al., 2020; Murshed 2020b). Several panel unit root test methodologies are available, which are Maddala and Wu (1999), Baltagi and Kao (2000), Hadri (2000), Levin et al. (2002), Im et al. (2003) and Choi (2001). All the variables used in this paper are tested in both level form and first difference form, with a deterministic trend. This study tested unit root problem by using summary of five panel-based methods proposed by Levin et al. (2002), which is referred as LLC, Breitung test by Breitung (2000), Im et al. (2003), referred as IPS, ADF-Fisher Chi-square and PP-Fisher Chi-square when deterministic trend is not included. When deterministic trend was included in panel unit root test, then the result included summary of five panel-based methods LLC, Breitung, IPS, ADF-Fisher Chi-square and PP-Fisher Chi-square. These panel unit root tests consider a common (LLC) or individual (Fisher type test using ADF and PP test) unit root across the cross sections (Esfahani and Rasoulinezhad, 2016). Hypotheses of panel unit root tests are as follows:

$H_0$ : Panel data has unit root

$H_1$ : Panel data has no unit root

### 4.2. Panel ARDL

Panel ARDL procedure is more significant approach to estimate regression results when all variables are not integrated in same

order rather if they are integrated to mixed order and to determine Co-integrating relationship in relatively small sample. This approach is first introduced by Pesaran and Shin (1999) and then expanded by Pesaran et al. (2001). Key ascendancy of Panel ARDL procedure is, if there is mixture of first difference,  $I(1)$  or level,  $I(0)$  one can only apply this approach; and in this situation, one cannot use any other approach. In simple words, this approach does not force that, all variables must have to be co-integrated in equal order. Panel ARDL method cannot be applied, if there is a mixture of level,  $I(0)$ , first difference,  $I(1)$  and second difference,  $I(2)$ . Another advantage of this approach is that, it deals in the long-run conjunction with in the short-run relationship (Dritsakis, 2011). Consistent estimation results are provided by autoregressive distributed lag approach when the sample size is small (Pesaran and Shin, 1999). Panel ARDL model provides both long-run and short-run estimates for panel countries.

Long-run and short-run Economic Growth Model:

$$\Delta LGDP_{it} = \beta_{1it} + \beta_{2it} LGDP_{i(t-1)} + \beta_{3it} LEP_{i(t-1)} + \beta_{4it} LK_{i(t-1)} + \beta_{5it} LLF_{i(t-1)} + \beta_{6it} LTO_{i(t-1)} + \sum_{j=0}^p \gamma_2 LGDP_{i(t-j)} + \sum_{j=0}^p \gamma_3 LEP_{i(t-j)} + \sum_{j=0}^p \gamma_4 LK_{i(t-j)} + \sum_{j=0}^p \gamma_5 LLF_{i(t-j)} + \sum_{j=0}^p \gamma_6 LTO_{i(t-j)} + \psi ECT_{i(t-1)} + \varepsilon_{lit}$$

Where,  $\varepsilon_{lit}$  is the white noise term,  $\Delta$  is the first difference operator and  $\psi$  is the coefficient of error correction term referred as ECT, which shows speed of adjustment revealing that, how swiftly variables' parameters converge to equilibrium at long-run. It is norm if its value lies between 0 and  $-1$ . The more it is near to  $-1$ , the more dynamic the equilibrium; but it must be significant. To ascertain the presen. If it is negative and significant, then there is a long-run linkages among the variables.

### 4.3. Panel FMOLS and DOLS

Following Murshed and Dao (2020) and Murshed (2020c), the Panel FMOLS and panel DOLS approaches are used for checking the robustness of the panel ARDL results for the entire panel group of Next 11 countries. FMOLS (Fully Modified Ordinary Least Squares) approach was developed by Phillips and Hansen (1990) and DOLS (Dynamic Ordinary Least Squares) approach was developed by Stock and Watson (1993). These two methods take into account the problem of serial autocorrelation and endogeneity and can be applied only when all the variables are stationary at first difference,  $I(1)$ . DOLS approach is considered better than FMOLS approach for various important reasons, such as; DOLS is computationally simpler than FMOLS, DOLS estimators are fully parametric and do not require pre-estimation and nonparametric correction and etc.

### 4.4. Panel Pairwise Granger Causality Tests

When Y is taken as dependent variable and X as independent variable, Granger causality test (Granger, 1969) then dictates whether past values of Y help to interpret present values of X as delivered by the data of past values of X itself. If previous

changes in Y do not help to illustrate the current changes in X, then Y does not Granger Cause X. In a similar way, it can be examined if X Granger-causes Y just by interchanging them and carrying out this process again. There could be four foreseeable outcomes: (a) Unidirectional causality from X to Y, that means X Granger causes Y; (b) Unidirectional causality from Y variable to X variable, that means Y Granger causes X; (c) Bidirectional causality that means both X and Y Granger causes each other; and (d) Independence that means neither of two variables Granger causes each other.

## 5. EMPIRICAL RESULTS AND DISCUSSIONS

Empirical results are discussed in this section.

### 5.1. Results of Panel Unit Root Tests

To determine stationarity of the variables, this study carried out panel unit root tests for the variables both at level and at first

difference, including individual intercept and trend. Estimated results in Table 3 show that, for the entire sample of Next 11 countries, there exists mixed orders of integration among the variables. Some of the variables are stationary at level, I(0) and some becomes stationary after 1<sup>st</sup> differencing, I(1). Thus, mixed degrees of integration lead to adopt Panel ARDL model to estimate the regression results of Equation (1). For the 6 N-11 net oil-importing countries, estimated results confirm that all of the variables are stationary at 1<sup>st</sup> difference, I(1). Thus, the study has adopted Panel DOLS model to estimate the regression results of Equation (2). For the 5 N-11 net oil-exporting countries, estimated results confirm that, some of the variables are stationary at 1<sup>st</sup> difference and some are stationary at level, I(0). Thus, mixed orders of integration lead to adopt Panel ARDL model to estimate the regression results of Equation (3).

### 5.2. Results of Optimal Lag Selection

Table 4 consists of the results of optimal lag length selection for the three panel groups according to the significant minimum lag values of LR, FPE, AIC, SC and HQ criterion. This study found

**Table 3: Results of panel unit root tests**

Variable	For all next 11 countries									
	At level, I (0)					At 1 <sup>st</sup> difference, I (1)				
	LLC	Breitung	IPS	F-ADF	F-PP	LLC	Breitung	IPS	F-ADF	F-PP
	t-stat.	t-stat.	W-stat.	Chi-square	Chi-square	t-stat	t-stat	W-stat.	Chi-square	Chi-square
LGDP	-1.48***	1.73	-1.07	31.31***	12.18	-4.69*	-4.26*	-5.77*	77.19*	121.59*
LEC	-1.74	0.53	-0.67	22.82	24.95	-10.17*	-4.81*	-9.33*	112.97*	294.43*
LEP	-6.76*	-0.91	-2.38*	33.62**	72.50*	-9.98*	-7.29*	-9.94*	120.60*	224.00*
LK	-2.24	1.51	-1.17	28.13	26.97	-11.60*	-7.83*	-10.35*	122.33*	229.23*
LLF	-1.71	1.32	0.58	16.55	14.06	-6.21*	-3.39*	-5.73*	70.90*	76.96*
LTO	-3.72*	-0.98	-3.99*	54.91*	33.48**	-10.82*	-6.73*	-10.55*	126.19*	322.59*
For 6 next 11 net oil-importing countries										
LGDP	-0.24	1.70	0.72	7.73	5.77	-6.29*	-6.21*	-4.79*	42.41*	89.36*
LEC	-0.36	0.69	0.13	10.09	16.95	-7.66*	-3.66*	-6.48*	59.79*	243.11*
LEP	-0.99	-0.68	-1.76	18.34	19.55	-7.37*	-5.37*	-7.34*	65.79*	122.18*
LK	-0.31	0.15	-0.69	16.05	13.79	-8.77*	-7.85*	-7.62*	67.06*	108.41*
LLF	-0.85	1.15	-0.19	11.93	10.07	-4.53*	-3.19*	-5.02*	45.52*	45.49*
LTO	-0.32	0.22	-1.35	11.04	15.85	-9.37*	-6.76*	-7.73*	68.09*	124.76*
For 5 next 11 net oil-exporting countries										
LGDP	-0.68	1.60	-1.84	17.88	6.41	0.69	-0.94	-2.66*	28.72*	32.23*
LEC	1.29	-1.45***	-0.01	6.84	7.99	-6.88*	-3.31*	-6.42*	50.93*	51.31*
LEP	-4.56*	-0.62	-1.61***	15.28	32.96*	-6.73*	-4.89*	-6.69*	54.82*	101.82*
LK	-2.43*	1.59	-2.59*	23.96*	13.17	-6.09*	-4.04*	-5.75*	46.28*	120.82*
LLF	-0.23	-0.49	0.32	7.02	3.98	-4.76*	-1.85**	-3.80*	31.10*	31.46*
LTO	0.24	-1.12	-3.19*	26.47*	17.63***	-1.92**	-1.83**	-4.65*	38.56*	197.83*

Source: Authors' own calculations. \*, \*\* and \*\*\* denote statistical significance of critical values at 1%, 5% & 10% respectively. LLC: Levin, Lin & Chu, IPS: Im, Pesaran & Shin, F-ADF: Fisher- Augmented Dickey Fuller & F-PP: Fisher-Phillips Perron

**Table 4: Results of tests for lag length selection**

Panel group	Lags	LogL	LR	FPE	AIC	SC	HQ
All next 11 countries	0	-899.082	NA	7.14e-05	7.480	7.566	7.514
	1	2137.455	5897.408	1.21e-15	-17.317	-16.712*	-17.073*
	2	2174.520	70.148*	1.20e-15*	-17.326*	-16.202	-16.873
6 N-11 net oil importing countries	0	-455.539	NA	4.39e-05	6.993	7.124	7.046
	1	1254.163	3238.072*	4.26e-16*	-18.366*	-17.448*	-17.993*
	2	1279.281	45.287	5.04e-16	-18.201	-16.497	-17.509
5 N-11 net oil exporting countries	0	-258.936	NA	4.98e-06	4.817	4.964	4.876
	1	989.169	2337.361	1.34e-15*	-17.221*	-16.190*	-16.803*
	2	1020.138	54.616*	1.47e-15	-17.129	-15.214	-16.353

Source: Authors' own calculations. \*Indicates lag order selected by the criterion. AIC: Akaike Information Criterion; FPE: final prediction error; HQ: Hannan-Quinn Information criterion; LR: sequential modified LR test statistic (each test at 5% level); SC: Schwarz information criterion



optimal lag 2 for Equation (1), optimal lag 1 for Equation (2) and optimal lag 1 for Equation (3).

### 5.3. Results of Cointegration Test

The panel unit root tests for the 6 N-11 net oil-importing countries confirm that all variables used in Equation (2) are stationary at I(1), then to test for evidence of a long-run relationship cointegration test is performed. Table 5 shows the result of Kao residual cointegration test for the 6 N-11 net oil-importing countries, which assumed the null hypothesis; there is no cointegration among the variables. The result confirms that, there exists cointegration and significant long-run association among the variables, because the null hypothesis is rejected at 1% significance level.

### 5.4. Results of Long-run and Short-run Elasticities Estimation

The long-run elasticities of economic growth with respect to energy consumption, energy prices, capital stock, labor force and trade openness estimates using Panel ARDL approach for the entire data set of N-11 countries are given in Table 6. LGDP is dependent variable. Table 6 portrays that; in the long-run, energy consumption positively affects economic growth. The estimated coefficient value attached to LEC means that, inferring all other determinants prevail unchanged, if N-11 countries' EC rises by 1%, then it will increase GDP (constant 2010 US\$) of N-11 countries by 0.19% on average, in the long-run. This result is consistent

with the results of Wasti and Zaidi (2020), Yang and Zhao (2014), Chiou-Wei et al. (2008), Yildirim et al. (2014), Shahbaz et al. (2013); Shahbaz and Lean (2012), Lee and Chang (2008), Lee et al. (2008), Apergis and Payne (2009a), Chontanawat et al. (2008), Wolde-Rufael (2009), Kaplan et al. (2011), Yavuz (2014) and Begum et al. (2015). Estimated coefficient value of LEP means that, inferring all other variables prevail constant, when EP rise by 1%, then in the long-run, it will decrease N-11 countries' GDP (constant 2010 US\$) by 0.06% on average. Results also show that in the long-run, capital stock variable has a negative association with economic growth. That conveys that, a 1% increase in N-11 countries' GCF (% of GDP) is prophesied to reduce GDP (constant 2010 US\$) by 0.03% on average, other variables remain constant. The estimated coefficient value attached to LLF means that, when all other prevailing variables are assumed to be constant, if LF rises by 1%, then in the long-run, it generates a rise in economic growth by 0.65% in N-11 countries. This result is consistent with the result of Hanif and Arshed (2016). The estimated coefficient value of LTO means, all other factors remain constant, a 1% rise in trade openness is conglomerated with a decrease in economic growth by 0.001% on average, in the long-run. But this result is theoretically inconsistent. The estimated coefficient value attached to the lagged ECT is  $-0.1934$ , that means, the long-run disequilibrium or imbalance in the dependent variable is being corrected by 19.34% in each short period. Table 6 also exhibits short-run elasticities of the respective variables on economic growth. The estimation results portray that; energy consumption variable has a positive correlation with economic growth in the short-run. The estimated coefficient value attached to LEC means that, considering all other determinants held constant, if EC accelerates by 1%, then it will increase GDP by 0.009% on average in the short-run. Coefficient value of LEP means, presuming all other determinants lie constant, when EP increase by 1% then this will decrease GDP by 0.03% on average, in the short-run. Results also portray a significant positive correlation between K and GDP; that means, a 1% rise in K is foreknowledge to increment GDP by 0.07% on average, ceteris paribus. This result is congruent with results of Apergis and Payne (2011) and Solarin (2011). Statistically insignificant and theoretically inconsistent results are found from the estimated coefficient values attached to LLF and LTO.

Panel FMOLS and Panel DOLS approaches are also used to check robustness of the results obtained from Panel ARDL approach for the whole Next 11 countries. The outcomes available in Table 7 show that, the results obtained from long run Panel ARDL are similar to the results obtained from Panel FMOLS and Panel DOLS approaches in term of sign. For both approaches, the estimated coefficients values attached to LEC and LLF are positive and also statistically significant at 1 percent significance level,

**Table 5: Result of Kao residual cointegration test for 6 N-11 net oil importing countries**

ADF	t-statistics	Prob.
	-3.349	0.0004

Source: Authors' own calculations

**Table 6: Results of long-run and short-run elasticities estimation using panel ARDL for all N-11 countries**

Variables	Coefficient	Std. error	t-statistic	Prob.
Long run equation				
LEC	0.19	0.081	2.444	0.015
LEP	-0.06	0.011	-4.842	0.000
LK	-0.03	0.042	-0.764	0.445
LLF	0.65	0.201	3.218	0.001
LTO	-0.001	0.021	-0.071	0.943
Short run equation				
ECT (-1)	-0.1934	0.087	-2.209	0.028
$\Delta$ LEC	0.009	0.118	-0.078	0.937
$\Delta$ LEP	-0.03	0.010	2.602	0.010
$\Delta$ LK	0.07	0.042	1.715	0.088
$\Delta$ LLF	-0.97	0.742	-1.319	0.189
$\Delta$ LTO	-0.07	0.027	-0.591	0.555
Constant	2.75	1.248	2.208	0.028

Source: Authors' own calculations

**Table 7: Results of long-run elasticities estimation using panel FMOLS and panel DOLS for all N-11 countries**

Variables	FMOLS	t-statistics	Prob.	DOLS	t-statistics	Prob.
LEC	1.288	1976.548	0.0000	1.239	9.073	0.0000
LEP	-0.009	-4.289	0.0000	-0.107	-1.881	0.0648
LK	-0.314	-384.671	0.0000	-0.582	-2.615	0.0112
LLF	1.167	24599.95	0.0000	1.281	21.403	0.0000
LTO	-0.375	-2763.608	0.0000	-0.435	-2.191	0.0323

Source: Authors' own calculations

reflecting a significant positive association with economic growth. Furthermore, for both approaches, the estimated coefficients values of LEP, LK and LTO are negative and statistically significant, reflecting a significant negative influence on economic growth. Panel FMOLS regression results from Table 7 can be interpreted by the estimated coefficients values attached to the variables. The estimated coefficient values of LEC and LLF can be interpreted as, all other variables held unchanged, a 1 percent rise in EC will accelerate GDP by 1.228% on average and if LF rises by 1%, then it will lead to economic growth by 1.167% on average. Again, the estimated coefficient value of LEP means that, when EP increase by 1%, then GDP (constant 2010 US\$) decreases by 0.009% on average, ceteris paribus. Variable K is significant at 1% significance level with estimated coefficient value of -0.314 attached to LK means that, when K increases by 1%, then GDP (constant 2010 US\$) decreases by 0.314% on average, ceteris paribus. Result also shows that, the estimated coefficient value of LTO means that, when TO increases by 1%, then GDP (constant 2010 US\$) decreases by 0.375% on average, ceteris paribus.

Panel DOLS regression results from Table 7 can be interpreted by the estimated coefficients values attached to the variables. The estimated coefficient values attached to LEC and LLF can be interpreted as, all other variables held unchanged, a 1 percent rise in EC will accelerate GDP by 1.239% on average, at 1 percent significant level and if LF rises by 1%, then it will lead to rise in GDP by 1.281% on average, at 1% significance level. Again, the estimated coefficient value of LEP means that, when EP increase by 1%, then GDP (constant 2010 US\$) decreases by 0.107% on average, ceteris paribus, at 10% significance level. Variable K is significant at 5% significance level with estimated coefficient value attached to LK means that, when K increases by 1%, then GDP (constant 2010 US\$) decreases by 0.582% on average, ceteris paribus. Result also shows that, the estimated coefficient value of LTO means that, when TO increases by 1%, then GDP (constant 2010 US\$) decreases by 0.435% on average, ceteris paribus.

Regression results of panel DOLS approach for the 6 N-11 net oil-importing countries' sample are presented in Table 8. The estimated coefficient values attached to LEC and LEP can be interpreted as; a 1% rise in EC, decreases GDP by 0.162% on average, ceteris paribus, but the result is not significant; and when EP rise by 1%, then it decreases GDP by 0.044% on average, at 10% significance level. These regression results mean that, energy consumption and energy prices negatively related with economic growth of these net oil importing N-11 member countries. Energy consumption varies with the up and down of energy prices. When oil prices are low, consumer use and import energy or oil in a greater amount which smooths the

path of industrialization and lead to the stimulation of economic growth. But as these countries are importer of oil then in the time of high oil prices they decrease their amount of oil import at a high price rate and then consumer also reduce their consumption because of high price which then lower their economic growth. It is evidenced from these empirical results that; how much this two variables are important for net oil importing countries' economic growth. Results also show that, K, LF and TO are positively related with GDP. The estimated coefficient value of

**Table 9: Results of long-run and short-run elasticities estimation using panel ARDL for 5 N-11 net oil exporting countries**

Variables	Coefficient	Std. error	t-statistic	Prob.
Long run equation				
LEC	-0.021	0.031	-0.690	0.493
LEP	0.059	0.005	12.931	0.000
LK	0.123	0.007	16.908	0.000
LLF	1.048	0.136	7.718	0.000
LTO	0.012	0.017	0.698	0.488
Short run equation				
ECT (-1)	-0.407	0.131	-3.109	0.003
ΔLEC	-0.189	0.172	-1.101	0.276
ΔLEP	-0.002	0.019	-0.080	0.936
ΔLK	-0.009	0.082	-0.115	0.908
ΔLLF	-2.521	2.333	-1.081	0.285
ΔLTO	-0.017	0.046	-0.377	0.708
Constant	3.191	1.002	3.183	0.002

Source: Authors' own calculations

**Table 10: Results of Pairwise granger causality tests for all N-11 countries**

Null hypothesis	F-statistic
LEC does not Granger Cause LGDP	0.100
LGDP does not Granger Cause LEC	4.620*
LEP does not Granger Cause LGDP	0.713
LGDP does not Granger Cause LEP	0.466
LK does not Granger Cause LGDP	1.671
LGDP does not Granger Cause LK	0.259
LLF does not Granger Cause LGDP	2.012
LGDP does not Granger Cause LLF	3.542**
LTO does not Granger Cause LGDP	1.559
LGDP does not Granger Cause LTO	1.358
LEP does not Granger Cause LEC	1.799
LEC does not Granger Cause LEP	0.130
LK does not Granger Cause LEC	5.019***
LEC does not Granger Cause LK	0.535
LLF does not Granger Cause LEC	1.716
LEC does not Granger Cause LLF	4.245*
LTO does not Granger Cause LEC	1.428
LEC does not Granger Cause LTO	1.033
LK does not Granger Cause LEP	0.880
LEP does not Granger Cause LK	0.383
LLF does not Granger Cause LEP	1.078
LEP does not Granger Cause LLF	1.307
LTO does not Granger Cause LEP	2.512***
LEP does not Granger Cause LTO	3.459**
LLF does not Granger Cause LK	0.426
LK does not Granger Cause LLF	4.008*
LTO does not Granger Cause LK	0.999
LK does not Granger Cause LTO	2.086
LTO does not Granger Cause LLF	2.283***
LLF does not Granger Cause LTO	0.048

Source: Authors' own calculations. \*, \*\* and \*\*\* denote the statistical significance of the estimated F-statistics at 1%, 5% and 10% levels of significance, respectively

**Table 8: Results of parameter estimation using panel DOLS for 6 N-11 net oil importing countries**

Variables	Coefficient	Prob.
LEC	-0.162	0.251
LEP	-0.044	0.083
LK	0.509	0.000
LLF	0.285	0.031
LTO	0.129	0.007

Source: Authors' own calculations

LK can be interpreted as, at 1% significance level, if K rises by 1%, it will raise GDP by 0.509% on average, *ceteris paribus*. So, gross capital formation (% of GDP) should be raised to stimulate GDP (constant 2010 US\$) in these countries. Again, the estimated coefficient value attached to LLF means that, other things held unchanged, when LF rises by 1%, it raises GDP by 0.285% on average, at 5% significance level. As, labour force is an important determiner of economic growth for these countries which is evidenced from the results, so efficient and productive labour force has to be formed to increase their GDP. Furthermore, the estimated coefficient value of LTO means that, at 1% significance level, a 1% rise in TO will lead to an increase in GDP of these countries by 0.129% on average, other things held constant. As trade openness is measured by Trade (% of GDP) in this study and it is a vital determinant of economic growth of these countries which is evidenced from the empirical results, so trade with other N-11 member countries and rest of the world will have to be encouraged and flexible trade policies should be formed to increase the contribution of trade to total GDP of these countries.

Regression results of panel ARDL approach for the 5 N-11 net oil exporting countries' sample is reported in Table 9, which narrates that; EC variable negatively affects GDP in the long-run. The estimated coefficient value of LEC means that, in the long-run, a 1% rise in EC will decrease GDP by 0.021% on average, *ceteris paribus*. The coefficient value attached to LEP

is positive and significant at 1% level. That means, assuming all other factors remain unchanged, if EP rise by 1%, then GDP will rise by 0.059% on average in the long-run. When oil price will rise these countries will export oil in a high price rate which will raise their earning from exports will contribute to their long-run growth process. The coefficient value of LK means that, if K rises by 1 percent, it will increase GDP by 0.123% on average in the long-run, remaining other variables constant, at 1% significance level. The estimated coefficient value of LLF means, holding all other variables constant, in the long-run, a 1% rise in LF generates an increment in GDP by 1.048%, on average. Finally, the coefficient value of LTO can be interpreted as, all else unchanged, when TO rises by 1% then it raises GDP by 0.012% on average, in the long-run. The coefficient value of the lagged ECT is  $-0.407$ , that means, the long-run disequilibrium or imbalance in the dependent variable is being corrected by 40.7% in each short period. Table 9 also shows the short-run elasticity of the respective variables on economic growth. All the estimated coefficient values attached to LEC, LEP, LK, LLF and LTO mean that, all the variables have a negative correlation with economic growth in the short-run. But none of these results is statistically significant.

### 5.5. Results of Causality Analysis

Results of panel pairwise Granger causality tests for the entire sample of Next 11 countries are reported in Table 10. Results indicate a unidirectional causal linkage is present between GDP

**Table 11: Results of pairwise granger causality tests for 6 N-11 net oil importing countries**

Null hypothesis	F-statistic
LEC does not Granger Cause LGDP	0.172
LGDP does not Granger Cause LEC	0.012
LEP does not Granger Cause LGDP	0.280
LGDP does not Granger Cause LEP	0.717
LK does not Granger Cause LGDP	0.724
LGDP does not Granger Cause LK	1.627
LLF does not Granger Cause LGDP	0.137
LGDP does not Granger Cause LLF	17.912
LTO does not Granger Cause LGDP	0.457
LGDP does not Granger Cause LTO	0.706
LEP does not Granger Cause LEC	3.044***
LEC does not Granger Cause LEP	0.127
LK does not Granger Cause LEC	8.429*
LEC does not Granger Cause LK	0.235
LLF does not Granger Cause LEC	0.042
LEC does not Granger Cause LLF	13.338*
LTO does not Granger Cause LEC	3.264***
LEC does not Granger Cause LTO	2.093
LK does not Granger Cause LEP	1.125
LEP does not Granger Cause LK	0.206
LLF does not Granger Cause LEP	0.756
LEP does not Granger Cause LLF	0.621
LTO does not Granger Cause LEP	0.218
LEP does not Granger Cause LTO	0.569
LLF does not Granger Cause LK	0.069
LK does not Granger Cause LLF	6.882*
LTO does not Granger Cause LK	0.521
LK does not Granger Cause LTO	4.589**
LTO does not Granger Cause LLF	3.487***
LLF does not Granger Cause LTO	1.882

Source: Own calculations. \*, \*\* and \*\*\* denote the statistical significance of the estimated F-statistics at 1%, 5% and 10% levels of significance, respectively

**Table 12: Results of Pairwise granger causality tests for 5 N-11 net oil exporting countries**

Null hypothesis	F-statistic
LEC does not Granger Cause LGDP	4.342**
LGDP does not Granger Cause LEC	6.986*
LEP does not Granger Cause LGDP	0.784
LGDP does not Granger Cause LEP	0.731
LK does not Granger Cause LGDP	3.923**
LGDP does not Granger Cause LK	1.832
LLF does not Granger Cause LGDP	6.789*
LGDP does not Granger Cause LLF	0.017
LTO does not Granger Cause LGDP	4.191**
LGDP does not Granger Cause LTO	0.583
LEP does not Granger Cause LEC	0.396
LEC does not Granger Cause LEP	0.502
LK does not Granger Cause LEC	4.488*
LEC does not Granger Cause LK	0.053
LLF does not Granger Cause LEC	2.644***
LEC does not Granger Cause LLF	0.967
LTO does not Granger Cause LEC	6.186*
LEC does not Granger Cause LTO	0.607
LK does not Granger Cause LEP	0.016
LEP does not Granger Cause LK	2.386
LLF does not Granger Cause LEP	2.076
LEP does not Granger Cause LLF	4.926**
LTO does not Granger Cause LEP	0.148
LEP does not Granger Cause LTO	1.169
LLF does not Granger Cause LK	0.163
LK does not Granger Cause LLF	2.618
LTO does not Granger Cause LK	1.509
LK does not Granger Cause LTO	2.071
LTO does not Granger Cause LLF	1.889
LLF does not Granger Cause LTO	0.782

Source: Own calculations. \*, \*\* and \*\*\* denote the statistical significance of the estimated F-statistics at 1%, 5% and 10% levels of significance, respectively



and EC at 1% significance level. That means, in case of entire Next 11 countries, GDP causes EC which validates the conservation hypothesis. Unidirectional causal associations are also found between GDP and LF at 5% significance level, between K and EC at 10% significance level, between EC and LF at 1% significance level, between K and LF at 1% significance level and between TO and LF at 10% level of significance. Results also indicate bidirectional causal association is present between TO and EP. No causal links are found between EP and GDP, meaning that energy prices have a minor role in determining GDP (constant 2010 US\$) of the N-11 group. Also the results do not confirm any causal linkage between EP and EC, meaning that energy prices have a minor impact on energy consumption (Kg of oil equivalent per capita) in the group of N-11 countries.

Results of panel pairwise Granger causality tests for the 6 N-11 net oil-importing countries are given in Table 11, which indicate that, at 10% significance level, a unidirectional causal association is found between energy prices and energy consumption. A unidirectional causal association also identified between capital stock and energy consumption at 1% significance level, between energy consumption and labor force at 1% significance level, between trade openness and energy consumption at 10% significance level, between capital stock and trade openness at 5% significance level and between trade openness and labor force at 10% significance level.

Results of panel pairwise Granger causality tests for the 5 N-11 net oil exporting countries are presented in Table 12, which show that, bidirectional causal linkage is stemming from energy consumption to economic growth for the 5 N-11 net oil-exporting countries which supports the feedback hypothesis and similar result is also found by Phrakhuropatnontakitti and Jermisittiparsert (2020) for 4 Asian countries. Results also show a unidirectional causal relationship is available between capital stock and economic growth, between labor force and economic growth, between trade openness and economic growth, between capital stock and energy consumption, between labor force and energy consumption, between trade openness and energy consumption and between energy prices and labor force.

## 6. CONCLUSIONS AND RECOMMENDATIONS

This paper empirically examined the impacts of energy consumption and energy prices on economic growth of N-11 countries from 1990 to 2013. The paper also examined energy consumption's and energy prices' impacts on economic growth of net oil importing N-11 member countries and net oil exporting N-11 member countries for the same period. To estimate the regression results, the study employed Panel ARDL method for N-11 countries and net oil exporting N-11 member countries; and Panel DOLS method for net oil importing N-11 member countries. Regression result shows that, energy consumption positively and energy prices negatively affect economic growth of N-11 countries both in the long-run and the short-run. It can be concluded from the regression result that, if these 11 countries consume more

energy it may stimulate N-11's economic growth which may further lead this Next 11 group to the pathways of becoming one of the most powerful economies in the world. Consumption of more energy is an indication of enhanced industrialization and growing urbanization, but it has to be kept in mind that there exists a positive nexus between energy use and CO<sub>2</sub> emission. So, N-11 countries will have to use energy in an environment friendly way and have to be aware about energy conservation for future. Another important thing can be inferred from these regression results is that, a persistent rise in spot crude oil prices may create a barrier to the path of growing economy of Next 11 countries. If spot crude oil prices rise frequently, it will decrease N-11's economic growth not only in the short-run but also in the long-run, as most of the member countries are importer of crude oil. Negative and significant estimated coefficient value of ECT shows the convergence and existence of long-run association. Result of Pairwise Granger Causality Tests for N-11 countries shows that, a unidirectional causal association is present between energy consumption and economic growth, but no causal linkage is running from energy prices to economic growth. Panel DOLS estimation results for net oil importing N-11 member countries show that, both energy consumption and energy prices negatively related with economic growth of net oil importing N-11 member countries. Panel ARDL estimation result for net oil exporting N-11 member countries shows that, in the long-run, energy consumption negatively and energy prices positively influences economic growth of net oil exporting N-11 member countries. While, in the short-run, both energy consumption and energy prices have a negative influence on economic growth of those countries. Negative and significant coefficient value of ECT assures the existence of long-run linkage.

The results derived from this study aid legislators and policy regulators a better comprehension of the magnitude of energy conservation and to formulate energy policies in these countries. This study also gives an important message to policy makers that energy infrastructures should be sustained and enhanced. Study on this specific subject matter raises consciousness about the probable impairment in economic growth which is a resultant of increases in energy prices. The adoption of appropriate energy pricing framework is very crucial for oil-importing countries because rise in crude oil prices badly damp economic growth of oil-importing countries. There is a necessity to expand research and development in the energy sector and in the renewable energy sources of N-11 countries, because these countries are consumer of significant portion of world's energy and these research works may help to augment economic growth of N-11 countries.

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