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Investigating The Nexus Between Oil Consumption Of OPEC And Global Oil Prices Using Panel ARDL Technique

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Abstract:
This paper examines the relationship between oil consumption of OPEC and global oil prices spanning from 1960 to 2020 using Pooled Mean Group Cointegration Method. Results of the study indicated that in a long run, there is no relationship between oil consumption of OPEC and global oil prices with error correction term and p-value of 0.217 and 0.001 respectively. This implies that the speed of adjustment to long run convergence following a disturbance in the long run is 21.7%. This result offers empirical evidence to the policies OPEC has put in place since it was established to ensure that all member states secure themselves against global oil price fluctuations.

Keyword- *Oil Consumption, Oil Prices, Pooled Mean Group Estimate, Im Persarin and Shin Test, OPEC*

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I. Introduction

Unarguably, oil production, consumption and its prices have significant effect on economic growth. In macroeconomic terms, fluctuation in oil consumption affects prices which in turn affects industrial production, employment rate and the health of most economies (Humbatova et al., ,2019). The state of most economies worldwide is highly dependent on oil and as such studies on oil and its related factors in any economy is vital. The effects of oil and its related factors on political and economic processes cannot be undermined.

Increments in oil prices have significant effect on price levels, inflation, economic revival, finance, stock market and economic development. Concurrently the formation of other alternative sources of energy are as well affected when oil prices increase (Humbatova et al., ,2019). Oil has been the world's most vital energy source (nonrenewable) since 1950 and plays an important role as an essential input in all economies worldwide and the primary source of energy (Doric, 2018). About 44% of global oil is supplied by the Organization of Petroleum Exporting Countries (OPEC). Fig 1 shows global energy sources.

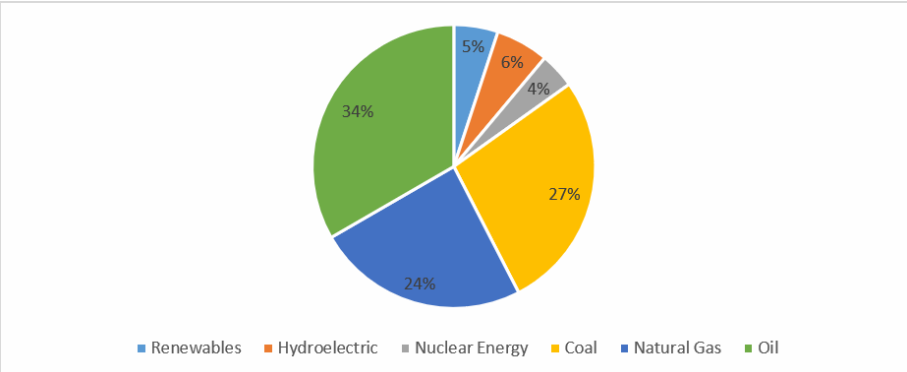

Figure 1 Pictorial view of sources of global energy (Source: BP Statistical Review)

OPEC is a cartel of fifteen countries including six in the Middle East (Iran, Iraq, Kuwait, Saudi Arabia, the United Arab Emirates, and Qatar), seven in Africa (Algeria, Angola, Congo, Equatorial Guinea, Gabon, Nigeria, and Libya), and two in South America (Ecuador and Venezuela).Oil is an important commodity for all major producers as its forms the backbone of their economies and is the driver of industrialization growth and development in these countries (Adom and Kwakwa, 2014; Cantach and Ansah,

2015). Since oil plays a vital role in the economy of every state, it is crucial to investigate the relationship between oil consumption other indicators that affects oil. In order to prevent demand and supply imbalances, examining the relationship between oil consumption and global oil prices is vital.

A plethora of studies have been conducted to examine the relationship between oil consumption and oil prices, Gurdarzi and Hossein (2012) used yearly data from 1980 to 2010 and employed Error Correction Model to assess the causal relationship between oil consumption and Gross Domestic Product (GDP) in Iran.

Njoya and Nijkan (2018) worked on the causal relationship between oil consumption in the transportation sector and economic growth in Cameroon. In the study, yearly oil consumption and GDP data spanning from 1975 to 2014 was used and time series technique was also applied. In literature only few studies have reported on the relationship between oil consumption of OPEC and macroeconomic indicators of OPEC.

Porhossingholi (2013) investigated the relationship between oil consumption and economic growth of OPEC member states from 1980 to 2011 using panel cointegration and panel-based error correction mode. Results of the study indicated that a long run relationship between oil consumption and GDP of OPEC.

Abbasinejad (2012) used cointegration and error correction modeling approach to examine the causal relationship of oil consumption and economic growth in OPEC member states with price as a third variable. The time series features of the variables were investigated using maximum likelihood techniques and the error correction and Granger Causality test. Based on the results of the study, there was an indirect Granger causality between oil consumption and economic growth for most of the member states while there was an existence of a direct Granger Causality in some of the countries.

Research on the relationship between oil consumption and other macroeconomic indicators such as oil prices and GDP has received a lot of attention among economists in recent times as the world's dependency on oil continues to rise (Appiah et al,2020). Majority of these studies conducted focused on individual countries (Appiah et al,2020). There are few works conducted on the relationship of oil consumption and oil prices, Considering the vital role of oil in the economy of OPEC member states this study contribute to literature by investigating the nexus between oil consumption of OPEC and global oil prices using the ARDL technique and more specifically the Pooled Mean Group Estimator.

II. Methods

Autoregressive Distributed Lag (ARDL) Model

An ARDL model is an Ordinary Least Squares (OLS) based model which is applicable for both non-stationary time series model as well as for time series with mixed order of integration. Equation () defines the generalized form of the ARDL (p, q,) model (Olungunde et al., 2020*).*

(*1*)

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Where and denotes the dependent variable and the vector representation variable that should be of either integration order 1 or zero. The lagged explanatory variable is denoted by and the coefficient vectors are denoted by and denotes the unit specific fixed effect . denotes the the optimal lag and is the error term whiles is the group specific speed of adjustments coefficient and is the vector of the long run relationship and the Error Correction Term (ECT) is denoted by and and represent the dynamic co-efficients of the short run.

To investigate the long run and short run relationship between oil consumption of OPEC and global oil prices in addition to or together with other variables considered in the study equation (3) was utilized. Panel ARDL was utilized in this study due to the fact that it incorporates both the cross sectional (N) and time series (T) features of the data and also allows for the usage of lagged dependent variable as regressors (Hassan et al,2019; Gujurati and Poter,2009). Two procedures are used in examining the long run relationship in ARDL approach the first step examing the long run relationship among variables which is known as cointegration. After the co-integration of the variables has been established, the next step will be to estimate the long-run coefficients using the ARDL model. The maximum Likelihood Estimator is then used to address the cross-equation restrictions existing in the long run parameters. In this study, the Hausman test is used to determine the validity of the restrictions and the Pooled Mean Group Estimator is used for the estimation. The PMG estimator was used in this study instead of other estimators such as DOLS and FMOLS in the panel study because the PMG gives vital evaluation on the presence of long run homogeneity in the relationship between oil consumption and oil prices. The decision rules are if ect is greater than or equal to 1 and less than or equal to -2.The Hausmann Test is then used to determine whether the Mean Group or Pooled Mean Group is suitable for the estimation.

Cross Sectional Dependency Test

Checking for Cross sectional dependency among panel data entities is crucial in panel data analysis (Yuzbashandi et al., Models To avoid model misspecification, which leads to erroneous tests, bias, and inconsistency, it is critical to assess cross-sectional dependence before modeling and estimating panel data (Yuzbashandi *et al*., 2020). To investigate cross-sectional dependency, the Breusch and Pagan LM test and the Cross-Sectional Dependency Lagrange test has been proposed in literature however, this method is suitable for has been widely employed. However, the Breusch and Pagan LM test is suitable for The he CDLM (Cross-Sectional Dependency Lagrange Multiplier) test is likely to reveal significant size distortion. [21] Pesaran [21] proposed a more general test that is reliable for both large and small panels as follow,

Pesaran Test

Breusch and Pagan (1980) proposed an LM statistic for Seemingly Unrelated Regressive estimate which is suitable for fixed N as T approached infinity (Type) and this can be expressed as (Equation 1).

Where the sample estimate of the pairwise correlation is denoted by .

4

The cross sectional dependency Langrange Multiplier Test usually show significant size distortions with large values of N and small values of T.] Pesaran [21] proposed a more general test that is reliable for both small and large values of N and T.

5

under the null hypothesis of cross sectional dependency CD approaches N(0,1) for N a and T sufficiently large. Under diverge range of panel data models such as homogeneous and heterogeneous models, the CD statistic has a mean of zero for constant values of T and N.

Hausman Test

The Hausman test also known as the Durban-Wu Hausman test can also be used to check model misspecification. was used to determine the validity of the long-run homogeneity restriction cross-country and the efficiency of the PMG estimator over the MG estimator. The has been used by alots of researchers because of its simplicity.

The hypothesis for the test:

: MG and PMG are not significanlty different but MG is more efficient

: MG and PMG are significantly different

Level of significance ( ) = 5%

Decision Rule 1: Reject if p-value is less than 0.005 use PM

Decision Rule 2: Accept if p-value is greater than 0.005 use PMG

Panel Cointegration Estimation- Pooled Mean Group Method

Panel data models are often estimated using two methods namely the Mean Group Estimator and the Random or Fixed and GMM techniques. The Mean Group Estimator gives accurate estimates of the average of the parameters (Persaren and Smith, 1995). According to Pirotte (1999) these estimates also give efficient long run estimates for large sample size. Moreover, it permits the parameters to be freely independent among groups and ignores the possibility of group homogeneity. On the other hand, the fixed models require the parameters to be the same across countries which could result in inconsistency in long term coefficient estimation. Persaren et al., (1999) introduced an intermediate estimator that permits short term parameters to vary between groups while imposing equality of long-term coefficients between countries (cite the paper). The PMG has the advantage of allowing different short-run dynamic specifications from country to country while keeping the long-run coefficients consistent (cite the paper). Additionally, unlike the Dynamic OLS and Fully Modified OLS the PMG estimators focuses on the short run and long run adjustment dynamic.

III. Main Result

Data Description

Yearly panel data spanning from 1973 to 2020 for ten OPEC member states namely Algeria, Angola, Iran, Iraq, Kuwait, Libya, Saudi Arabia, UAE and Venezuela was used in this study. The data for oil consumption, oil production, Gross Domestic Product, Population Growth, Oil Prices, Value of Oil Imports, Value of Oil Export of these member states was sourced from the OPEC website (Data download (opec.org). In order to reduce the effects of unbalanced valuers, small size and outliers, the natural logarithm of all the variables under consideration was taken.

Table 1 Descriptive Statistics of OPEC macroeconomic indicators

Macroeconomic Indicator	Minimum	Maximum	Mean	Standard Deviation
Gross Domestic Product (GDP)	26000	3400000	940000	1000000
Values of Oil Export (VOE)	4700	1100000	270000	300000
Values of Import (VOI)	4200	910000	240000	280000
Oil Production (OP)	3000000000	540000000	260000000	280000
Population Growth (PG)	1.48	1.96	2.53	150000000
Oil Prices (COP)	109	1750	36.4	29.3
Oil Consumption (OC)	8800	240000	3900	2800

Panel Unit Root Test

The first step in panel data analysis is to check for the presence of unit root test in the panel data. According to Kim et al., (2010) panel ARDL can be used for variables that are either of integration order zero I(0) or one I (1) and cannot be used for I(2) or higher series. In this study, the Im Persarin and Shin was used to ascertain that all the variables considered in the study were either of integration order 1 or 0. Based on the results of the Im Persarin Test (Table 2) all the variables considered in the study were either of integration order 1 or 0. From the table Oil prices and GDP were differenced once to attain stationarity I (1) whiles Oil consumption, Values of Petroleum Export, Values of Imports, oil production and Population Growth were of integration order 0. The next phase of the analysis after the panel unit root test is to determine whether or not there is evidence of cointegration

Table 2 Results of Im Persarin and Shin Unit 1Root Test for Panel Data

Default lag length =1	LEVEL		FIRST DIFFERENCE		Order
Variable	**Statistic**		**Statistic**		of
	W-T-Bar	P-Value	W-T-Bar	P-Value	Integration
lnODE	-3.3366	0.0004	N/A	N/A	I(0)
COP	0.0119	0.5047	-9.1849	0.00	I(1)
lnGDP	-1.4243	0.0772	-10.5699	0.0000	I(1)
lnVPE	-3.0580	0.0011	N/A	N/A	I(0)
lnVIP	-12.5935	0.0000	N/A	N/A	I(0)
lnCRP	-8.0389	0.0000	N/A	N/A	I(0)
PGR	-6,2712	0.0000	N/A	N/A	I(0)

Panel Cointegration Test

Having ascertain the fact that all the variables were of either integration order 0 or 1 the next step is to test for the existence of long run relationship between the variables. In order to examine the panel cointegration relationship between the variables the ECT term and the T-statistics was used.

From Table 2 the ECT is negative and significant at 1% based on that, cointegration can be inferred among the variables. Moreover, since the absolute value of the T-statistic is greater than 1.95 it implies that the ECT coefficient is significant and for that matter cointegration can be inferred The ECT represent the speed of adjustment that correct any short-term equilibrium and long run convergence.

Hausman Test Results

Table 4 shows the results obtained from the Hausman Test, From table 4 it can be observed that the p-value is 0.4569 which is more that 0.05%. As a result, under the null hypothesis of homogeneity that indicate that PMG is more efficient estimator) the alternative hypothesis was rejected. This implies that the PMG is more suitable for the model than the MG. Accordingly, the results of the study were derived from the PMG estimation technique since the null hypothesis was accepted

Table 3 Results of Im Persarin and Shin Unit 1Root Test for Panel Data

	MG	PMG	Difference	SE	P-Value

COP	-0.0046771	-0.01342	-0.003351	.0025319	0.4569
In GDP	-039867	-1144008	-.745339	.2991534	
In VPE	.004972	-.1250138	.125511	-1435814	
In VIP	.4952037	.464178	.0327859	.1824924	
In CRP	.2034323	.094265	.1091672	.2243787	
PGR	.0161699	-.0101326	.0263025	.636085	

Panel Cointegration Estimations: Pooled Mean Group Results

Based on the PMG estimates in Table 6.2 there is no long run effect of oil consumption of OPEC member states and global oil prices at 5% significance level. This result offers empirical evidence to the policies OPEC has put in place since it was established to ensure that all member states secure themselves against global oil price fluctuations. It can also be observed form the table that no long run effect of oil consumption of OPEC and GDP, Oil production and population growth. However, there was a long run relationship between oil consumption of OPEC and value of oil importation. The PMG estimator was then used to investigate the short run effect of oil consumption and oil price of the ten OPEC member states considered in the study. Though there was no long run relationship between oil consumption and global oil prices for OPEC as a cartel, there was a short run relationship between oil consumption and oil prices for individual member states.

An in

Table 6.4 shows the short run effect of oil consumption and crude oil prices, Gross Domestic Product, Values of Oil Import, Values of Petroleum Export and Population Growth for Algeria.

Based on the results of Table 6.4 there is a significant relationship between Algeria's oil consumption and international oil prices. A unit change in global crude oil prices of Algeria, Iran, Nigeria, SaudiArabia and Venezuela will cause 0.00635, 0.00175,0.00104, 0.00003,0,000306 increase in oil prices whiles A unit change in global crude oil prices of Angola,Iraq,Kuwait,Libya and United Arab Emirate,0,00038, will cause 0.00180, 0.0003285, 0.0014,0.002 decrease in oil consumption.

From Table 6.2, there is a long run relationship between oil consumption and Population Growth, Values of Petroleum Exports and Values of Import

Table 4

Country	Coefficients	Std. Error	P-Value	Decision
Algeria	0.0008	0.0000	0.0000	EM
Angola	-0.0030	0.0001	0.0001	EM
Iran	-0.0002	0.0000	0.0000	SS
Iraq	-0.0001	0.0000	0.0000	SS
Kuwait	-0.0008	0.0000	0.0000	SS
Libya	-0.0025	0.0000	0.0000	EM
Saudi Arabia	0.0003	0.0000	0.0000	EM
UAE	-0.0002	0.0000	0.0000	SS
Venezuela	-0.0001	0.0000	0.0000	SS

Table 5 PMG Cross-sectional Short-run Coefficients (COP)

	D.OC	Coefficient	Std. Error	T-Statistic	P-Values
ECT(LR)					
	InOP	-0.001342	0.0010253	-1.31	0.191***
	In GDP	.1144008	0.0658136	1.74	0.082***
	In VIP	.4624178	0.0674567	6.86	0.0000***
	In VPE	-.1250138	0.0480384	-2.60	0.009**
	In CRP	-0.094265	0.0557514	1.69	0.091***
	PGR	-0.0101326	0.0038358	-2.64	0.008
SR					
	ECT	-0.2173288	0.0633553	-3.43	0.001***
	OP				
	D1	-0.0007356	0.0003997	-1.84	0.066
	InGDP				
	D1	0.0306143	0.0208187	1.47	0.141**
	In VPE				
	D1	0.033279	0.0231026	1.44	0.150
	In VIP				
	D1	.1640615	0.0584039	2.81	0.005
	In CRP				
	D1	-0.0022714	0.1988335	0.01	0.991
	PGR				
	D1	-0.008638	0.0099609	-0.89	0.37
	_cons	-.1071879	0.077577	-1.38	0.167

Where SIS =Statistically Insignificant at 1% significance level; SS=Statistically Significant at 1% significance level; EM=Explosive Model

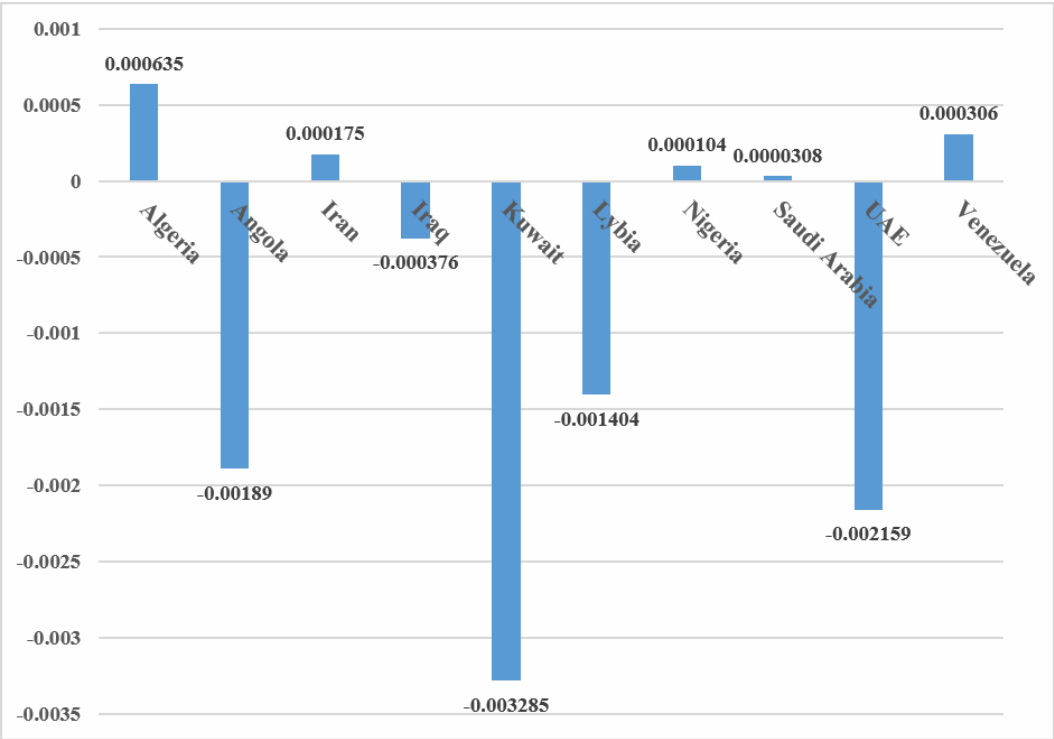

Fig 2

IV. Conclusion

In this study, the relationship between oil consumption and oil prices of OPEC was examined using panel cointegration technique. In order to check for the integration order of the variables considered in the study the Im Persarin and Shin test was used to ascertain that all the variables considered in the study were either of integration order 1 or 0. Furthermore, the Error Correction Term was used to determine the existence of cointegration it was observed that, the ECT is negative and significant at 1% based on that, cointegration was inferred among the variables.The Hausman Test was used to determine the validity of the long-run

homogeneity restriction cross-country and the efficiency of the PMG estimator over the MG estimator based on the results of the Hausman test the PMG was more suitable for the model than the MG. Based on the PMG estimates in Table 6.2 there is no long run effect of oil consumption of OPEC member states and global oil prices at 5% significance level. Though there was no long run relationship between oil consumption and global oil prices for OPEC as a cartel, there was a short run relationship between oil consumption and oil prices for individual member states

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