Journal
IJCSM

Iraqi Journal for Computer Science and Mathematics

Journal Homepage: http://journal.esj.edu.iq/index.php/IJCM
e-ISSN: 2788-7421 p-ISSN: 2958-0544

Estimating Long-run Elasticity between Crude Oil Consumption, Real Oil Price, and Real GDP in Global Markets

Aysar Y. FAHAD*[1], Ahmad Hussein BATTAL[2], Asmaa YASEEN[3]

[1]College of Administration and Economics, finance and banking department, Al Iraqia University, Baghdad, IRAQ

[2]College of Administration and Economics, University of Anbar, IRAQ
Organization Address, Anbar, 2154, Iraq

[3]senior modeling and forecasting analyst at OPEC, Vienna, Austria

DOI: https://doi.org/10.52866/ijcsm.2023.02.02.009
Received December 2022 ; Accepted Februry 2023 ; Available online March 2023

ABSTRACT: The study examine the long-run relationship between crude oil consumption, real oil price, and real GDP using a quarterly time series from 1993 to 2020. the empirical analysis uses the Dynamic Least Squares (DOLS) model for both short-run and long-run elasticity among the model variables to estimate the short-run and long-run elasticity of demand for crude oil consumption in 10 regions using Panel Dynamic Least Squares (DOLS) and Pooled Mean Group-AR Distributed Lag Models (PMG/ARDL). The empirical analysis findings confirme that the demand for crude oil internationally is highly insensitive to changes in price and real GDP.

Keywords: crude oil consumption elasticity, oil prices, real GDP, DOLS, PMG/ARDL, Global oil Markets

1. INTRODUCTION

Over the past several decades, the oil market has proven itself unique in terms of its diversity and complexities, as a result of being subject to a wide range of interlocking and changing factors at the same time, which affect oil supply and demand. The oil market does not know stability, and is characterized by permanent fluctuation, as a result of several economic and non-economic factors, as it is still The global oil market is subject to a wide range of risk factors, including natural disasters, major technical accidents, and geopolitical tensions some of which can be foreseen, some of which are unpredictable.

As the economies of crude oil-consuming and exporting countries depend on oil linked to the global economy as a major source of revenue and therefore GDP, and this is a major challenge as a result of the changes in oil prices in the global market and highlighted the importance of oil in all areas, political, military and economic. It is considered one of the most important economic resources that boosted the effectiveness of economic activities. The fluctuations in oil prices are reflected in most of the macro indicators in the economy. The increase in the growth rate of the exports of oil-producing countries due to the high prices will lead to higher revenues and increased government spending.

The oil market is characterized by characteristics and features that differ from the rest of the other markets, due to the nature of this substance as it is a depleted resource. Therefore, it can be said that the rise in oil prices increases the revenues of the producing and exporting countries, as their financial revenues increase, which positively affects the preparation of their budget, but this rise in prices negatively affects the consuming countries, and the case is opposite in the case of low oil prices and conflict of interests between consumers and producers.

The paper hypothesizes that the elasticity of world consumption of crude oil in the short and long term is a function of the change in its real prices and gross domestic product.

We can say that the oil markets have important advantages and characteristics, which are [1]:

1.1 Monopoly: Member countries of international organizations, whether they are the oil-producing countries in “OPEC” or the industrialized oil-consuming countries, seek to defend their interests through these organizations, especially since the developed countries have described “OPEC” as a monopolistic organization, and its decisions harm the interests of countries. (the expendable), that is why the International Energy Agency was created to organize its defense against OPEC.

*Corresponding author: aysar.fahad@aliraqia.edu.iq, tradepolicies@yahoo.com

1.2 Importance: The reason for the instability of the oil market is due to the growing importance of oil in the international economy due to its total dependence on it being a relatively cheap source of energy, and it enjoys great demand, so its importance comes from two aspects, namely the economic and strategic aspect of most countries of the world.

1.3 Volatility: price instability due to changing supply and demand, and there is no specific pattern that can predict oil prices, due to the presence of several overlapping factors, which leave a clear impact on prices[2].

2. BACKGROUND

Economists have done since Marshall and until now, when drawing the curves of both supply and demand, that the vertical axis is assigned to the independent variable, which is the price, while the horizontal axis is allocated to the dependent (responsive) variable, which is the quantity demanded or the quantity supplied because they consider the price as It is affected by the costs of the factors of production, or by the degree of monopoly, and in some cases, it is subject to central pricing policies, while the quantities demanded are an expression of buyers' conviction in its price, so the quantity they demand of the commodity is determined, while the quantities offered are an expression of the producers' conviction in this price, so the quantity they offer is determined for sale [3].

However, the reality of the situation and the economic logic indicates that there is a mutually influential relationship between the price on the one hand and the quantities supplied and the quantities demanded, on the other hand, meaning that the price can once be the independent variable and the quantities are the dependent variable, as is usual, and the quantities can be the independent variable and the price is the dependent variable, as commodity prices decrease as their supply increases or demand decreases, and the opposite is true for both (Samuelson & Nordhaus, 2010). Certainly, this economic logic applies to crude oil, despite its specificity, which we mentioned earlier, If you see a decrease in the price of oil, for example, the reason is either that the oil demand has decreased, or because the supply of oil has increased, and there is an indication that the quantity demanded or supplied directly affects the price, but it goes back to saying, that if you know the price of a commodity, You will know how much consumers will demand from them, which means that price affects the quantity demanded [4].

Numerous factors play a role in determining the price elasticity of demand, including the presence of substitute goods close to that good, the importance of the commodity in terms of total public and personal spending, the time when prices change, and the range of uses [5].

3. METHOLOGY

3.1 MODEL AND DATA

A quarterly time series of crude oil consumption, real oil price, and real GDP from 1993 to 2020 was used to estimate the long-term and short-term details of oil consumption. Specifically, the long-term and short-term GDP growth and the price elasticity of oil consumption were calculated using the following method: Panel Dynamic Least Squares (DOLS) and Pooled Mean Group-AR Distributed Lag Models(PMG/ARDL) for main countries and regions in the world that represent 100% percent of global oil demand.

3.2 MODEL SPECIFICATION

It is possible to express the relationship between oil demand, real GDP, and oil price as follows:

DO = F(GDP , BP) ……………..1

Where The DO represents oil demand (mb/d), GDP represents constant prices in 2015, $ million, while the BP represents Brent real prices in 2003-2020.

An empirical model for cross-sectional data can be formulated as follows:

$$DO_{it}=b_{o\ i}+b_1\ GDP_{it}+b_2BP_{it}+\varepsilon_t \quad \ldots\ldots.2$$

b0 represents the constant, while b1 and b2 correspond to estimates of the parameters. The data offered in this subscript I represent cross-sectional data for a panel of countries and cover quarterly time series from 1993 to 2020. It is assumed that the random disturbance term ε_t has zero mean and constant variance and is normally distributed. The regressors in the model are their elasticity of income $b_1\ GDP_{it}$ and elasticity of price of oil demand b_2BP_{it}.

3.3 THE HETEROGENEOUS PANEL UNIT ROOT

In the first step, we examine whether our data set contains a panel unit root to examine whether we can derive panel cointegration. Several methods can be used for testing whether a panel unit root exists. In our study, we utilized the Breitung and Im, Pesaran, and Shin tests [6]. Narayan and Smyth, as well as Monte Carlo simulations, were used by Hlouskova and Wagner [7], panel unit root test has also been used. Furthermore, the test provides t-test statistics that follow the standard normal distribution [8] Each cross-section receives a separate estimation, allowing for the specification of the parameter values, residual variance, and lag length, [9]. Furthermore, the test can be performed with high power, with little distortion, and also for small samples [9]. Separately, the Augmented Dicky-Fuller (ADF) test is as follows:

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{it-1} + \sum \delta_j Y_{t-1} + \beta_{it} + \varepsilon_t \dots\dots\dots 3$$

It is assumed that T should be the same across the cross-sections to perform this test. An average t-statistic is the sum of each separate ADF t-statistic for a test $\rho_t = 0$ for all cross-sections. $\bar{t} = \frac{1}{N}\sum_{t-1}^{N} t_{pt}$. [8] Using the t-bar when N and T are small, the performance is better.

3.4 THE HETEROGGENEOUS PANEL CO-INTEGRATION TEST

By applying Pedroni's panel co-integration test, we can determine whether there is a long-run co-integration relationship between oil demand, real GDP, and the price of oil after examining the presence of a panel unit root. [11]. A test of co-integration in a heterogeneous panel's framework permits the inclusion of multiple regressions and estimates residuals from co-integration regressions and provides seven test statistics. It allows for the cointegration vector to vary across the sections in the panel as well as heterogeneity between the cross-sectional units of the panel. The estimated residuals from the long-run regression are as follows:

$$Y_{it} = \alpha_i + \pi_{it} + \sum_{m=1}^{M} \beta_{mt} X_{mit} + \mu_{ti^1} \qquad \dots\dots\dots\dots \quad [4]$$

$$t = 1 \dots . T, i = 1 \dots . N; m = 1 \dots . M$$

Time-specific observations are represented by T, while cross-sectional units are represented by N, and regressors by M. The intercept and slope coefficients vary by cross-sectional units. Pedroni has used the critical values for the seven test statistics using the Monte Carlo simulations, It proposes that if the values of the test statistics exceed the critical values, the null hypothesis of no co-integration must be rejected [11].

Developing long-term relationships with Panel

After confirming the existence of a long-term cointegration relationship, we apply the recently introduced DOLS advocated by Saikkonen [12], while Kao and Chiang advocated panel DOLS to examine the long-run relationships between the variables in the model in Stock and Watson (1993)[10]. In contrast to OLS and Fully Modified Ordinary Least Squares (FMOLS), the panel DOLS method involves lags and leads of the regressor [10].

Model estimation for Pooled Mean Groups/AR Distributed Lags (PMG/ARDL)

Pesaran and Smith (1995) introduced the Mean Group (MG) estimator as a simple estimator of panel data with many time-series observations for each of the N groups. Consider estimating an ARDL (p, q) The following model is based on a panel dataset with groups indexed by i = 1, 2, . . . , N and periods indexed by t = 1, . . . , T, where T is large enough to be able to estimate the model consistently for each group[13].

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} * y_{i,t-j} + \sum_{j=0}^{q} \delta^{1}_{ij*} x_i + y^1 d_t + \varepsilon_{it}, \qquad \dots\dots\dots [5]$$

where xit and dt are k ×1 and s×1 The regressors are vectors, while the λij∗s are unknown scalars and the δij∗s and γi∗ s are k × 1 and s × 1 Unknown parameter vector to be estimated [14].

4. DATA

The data period extends from the first quarter of 1993 to the fourth quarter of 2020, for these regions and consuming countries in the world, which are Africa, Americas, Asia Pacific, China, Europe, India, Latin America, Middle East, Other Asia, and the USA.

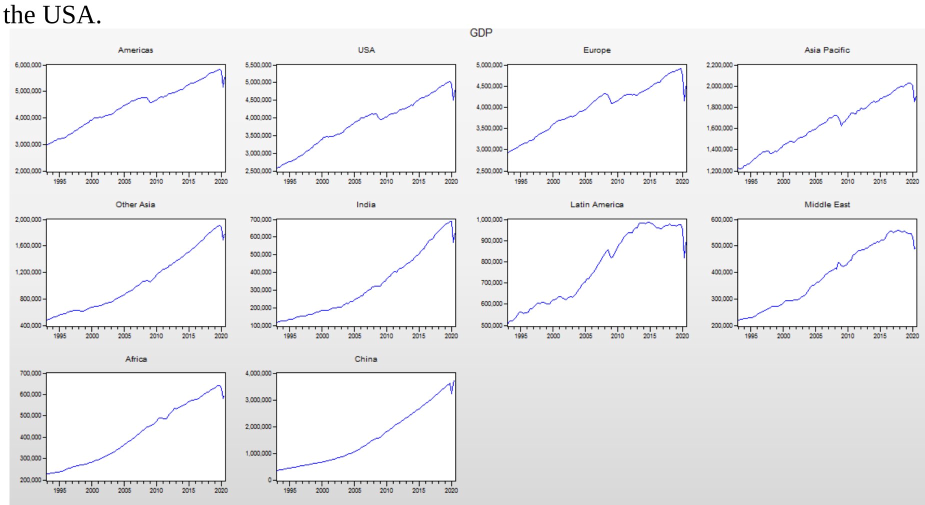
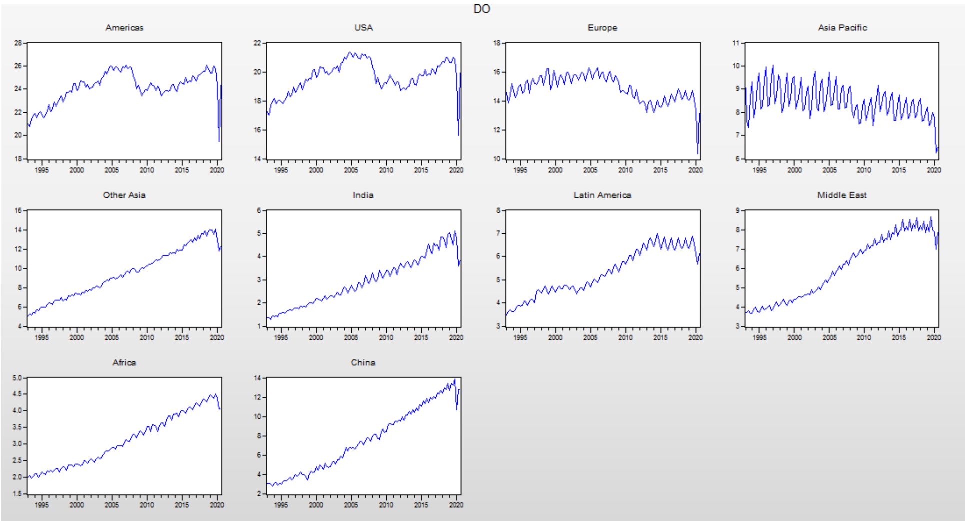


Figure 1 Development of global GDP in the major countries and regions of the world

Source: Researchers finding based on data collected from Oxford Economics

Fig. 1, shows that most of the selected countries and regions witnessed an increase in their GDP, except for the period 2008-2010 when this indicator fell sharply as a result of the mortgage crisis that swept the world. The global economy witnessed September of 2008 this crisis, which was considered the worst and most serious financial crisis since The time of the Great Depression in 1929, a crisis that shook the pillars of the American economy, which is considered the largest and most influential in the world, and the various economies of the world, starting with Europe, emerging and developing Asian countries and therefore to the Middle East as a result of the decline in global growth and demand for Crude oil then spreading to Africa. Also, the GDP was greatly affected in the last quarter of 2019 by the Corona pandemic, which had a great impact on the overall production processes due to the disintegration of production rings between different countries and the decline in global demand for oil as a result of the complete health closure measures taken in most parts of the world at that time [15] which can be seen very clearly in Fig. 2. The sudden decline of oil prices as the result of the decline in Oil consumption all around the world sent big shockwaves throughout the global economy.



Figur 2. Oil consumption in major countries and regions of the world
Source: Researchers finding based on data collected from Oxford Economics

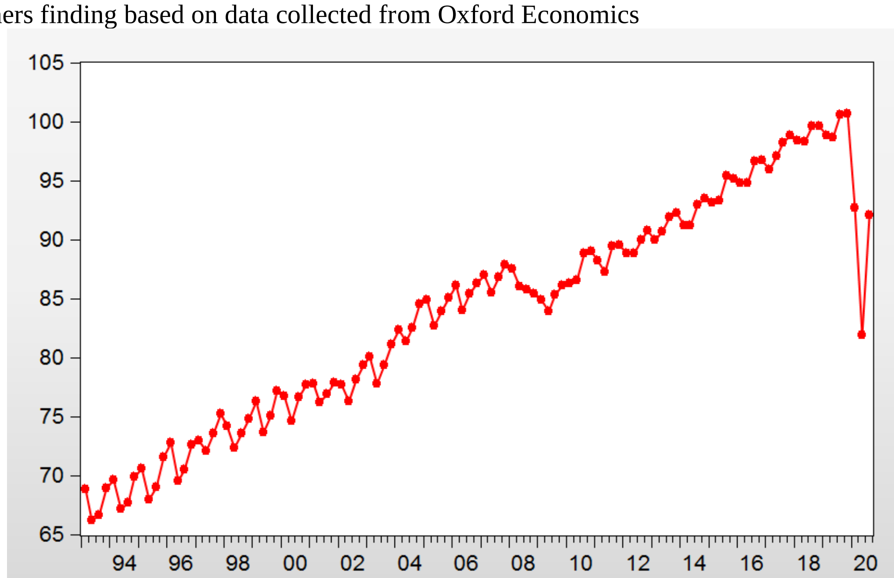


Figure 3. Brent oil prices for the period 1993Q1 until 2020Q3
Source: Researchers finding based on data collected from Oxford Economics

5. RESULTS AND DISCUSION

5.1 PANEL UNIT ROOT TEST

Table (1) shows the results of the Panel Unit Root Test for the variables of this research, as follows:

Table 1. PANEL UNIT ROOT TEST RESULT

Variables	Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square	
	Individual effects	Individual effects, individual linear trends	Individual effects	Individual effects, individual linear trends
DO	0.85046	1.59669	13.5737	15.3781
ΔDO	4.69284***	3.09805***	64.1485***	47.9491***

GDP	1.20100	2.15901	11.5332	9.98529
ΔGDP	-3.83200***	1.11065	50.3591***	30.5453*
BP	-1.28876	1.65975	20.8061	6.12469
ΔBP	13.3325***	-12.4890***	211.394***	174.778***

* statistical significance at 10 percent level
** statistical significance at 5 percent level
*** statistical significance at 1 percent level
Source: Researchers finding using Eviews 10

table 1 shows the Panel Unit Root Test result for the variables of the research, which shows that all variables are not stationary at the original level of the data, and the variables become stationary when the first difference is taken according to the Im, Pesaran and Shin W-stat test and the ADF - Fisher Chi-square test, so The PEDRONI PANEL COINTEGRATION method can be applied for panel data integration.

5.2 5.2 Hsiao's test for heterogeneity of cross-sections

table 2 shows Hsiao's test for heterogeneity of cross-sections [16].

table 2 test for heterogeneity of cross-sections

Hypotheses	F-Stat	P-Value
Alternative Hypothesis : panel is heterogeneous	160.9164	0.00000

Source: Researchers finding using Eviews 10

table 2 shows that we accept the alternative hypothesis for heterogeneity of cross-sections

5.3 PEDRONI PANEL COINTEGRATION INTEGRATION TEST

Table 3 shows the result of the Pedroni Panel Cointegration integration test as follows:

Tab. 3. PEDRONI PANEL COINTEGRATION

	Statistic	Prob.
Panel v-Statistic	21.57529	0.0000
Panel ρ-Statistic	-25.85972	0.0000
Panel PP-Statistic	-19.02978	0.0000
Panel ADF-Statistic	-21.45901	0.0000
Group ρ -Statistic	-25.81890	0.0000
Group PP-Statistic	-20.10170	0.0000
Group ADF-Statistic	-18.88742	0.0000

Source: Researchers finding using EViews 10

Table 3 shows the existence of a joint integration between the demand for oil as a dependent variable and the GDP and price as independent variables during the research period and according to all the tests that were employed in the joint integration test, so other standard methods that show the elasticity of demand for oil at the aggregate level can be applied as well as on the level of each region.

5.4 DYNAMIC LEAST SQUAIRS (DOLS) RESULTS

After making sure that there is co-integration between the variables used in the research, Table 4 shows the results of the Dynamic Least Squares methodology to extract the elasticity of output and prices in the long run.

Table 4 DOLS LONG-RUN ELASTICITY

	C	**GDP**	**BP**
PANEL DOLS	**-**	**0.720*****	**-0.054*****
Africa	**-8.877*****	**0.780****	**-0.0255****
Americas	**-0.541**	**0.245*****	**-0.009**
of which USA	**-0.458**	**0.231*****	**0.022**
Asia Pacific	**6.055*****	**-0.280*****	**0.021**

China	**-7.415*****	**0.649*****	**0.051***
Europe	**4.539****	**0.118**	**0.013**
India	**7.250*****	**0.645*****	**0.043**
Latin America	**10.620*****	**0.916*****	**-0.037***
Middle East	**9.638*****	**0.881*****	**0.024**
Other Asia	**6.722*****	**0.641*****	**0.026**

* statistical significance at 10 percent level
** statistical significance at 5 percent level
*** statistical significance at 1 percent level
Source: Researchers finding using EViews 10

Table 4 shows the long-term results at the global level, through which we note that the elasticity of demand concerning the output has a positive expected sign and its value is (0.72) which is less than one, which means that an increase in output by 1% leads to a lesser increase in demand for oil globally. Brent's price elasticity also showed the expected negative sign, and its value was (-0.054), which is a small response, which means that a rise in the price may necessarily reduce the oil demand worldwide. These results are in agreement with the results of the study [17] and in particular with the income elasticity. The results also show at the level of regions and major countries that the income elasticity ranges between the highest value (0.91) in Latin America and the lowest value (0.11) in Europe and bears the expected positive sign, and we find that the income parameter (-0.28) in the Asia Pacific bears the unexpected sign The reason for this is that oil consumption in this region is in a state of continuous decline, especially in recent years (see Figure 2), and this confirms the inverse relationship between income and the amount consumed in this region. As for the inverse price elasticity, it ranges between the highest value (0.05) in China and the lowest value (-0.025) in Africa, while the price elasticity for the rest of the regions showed the unexpected sign, and the reason for this is that high oil prices may often lead to Increasing demand for oil due to hedging against future price hikes, and as Fig. 3. shows, the increasing upward trend in Brent oil prices during the research period with the increasing trend in demand for crude oil in most regions of the world, as shown in . 2.

5.5 POOLED MEAN GROUP-AR DISTRIBUTED LAG MODELS (PMG/ARDL) RESULTS

Table 5 shows the results of estimating the elasticity of demand for oil according to the (PMG/ARDL) method. Before applying this method, it was confirmed that there is a co-integration according to the bound test and as in Annex (1)

Table 5 **Panel PMG/ARDL Oil ELASTICITY**

	GDP	**BP**
Panel PMG/ARDL	**0.161*****	**-0.059*****
Panel (PMG/ARDL) Short-RUN ELASTICITY		
Africa	**0.943*****	**-0.041*****
Americas	**2.164*****	**0.0155*****
of which USA	**2.330*****	**-0.009*****
Asia Pacific	**3.027*****	**-0.110*****
China	**0.928*****	**0.089*****
Europe	**2.076*****	**-0.037*****
India	**1.269*****	**-0.063*****
Latin America	**0.570*****	**0.030*****
Middle East	**0.592*****	**0.045*****
Other Asia	**0.913*****	**-0.004*****

* statistical significance at 10 percent level
** statistical significance at 5 percent level
*** statistical significance at 1 percent level
Source: Researchers finding using EViews 10

From Table 5, the results show that the income elasticity of oil demand amounted to (0.16) at the world level, which is a positive sign as expected, and this elasticity is low compared to the individual results for each region. The price elasticity also shows the expected negative sign and it reached (-0.057) at the world level It is weak and indicates the weak impact of the price in reducing the demand for oil at the global level despite the high oil prices, meaning that the price elasticity of demand is weak. These results are in agreement with the study [18]

The results show that the income elasticity at the level of different regions has a different effect, but all of them bear the expected sign, which is statistically significant at a lower level (0.01), but the size of the effect varies from one place to another, and the reason for this may be due to the different levels of income in the regions of the world, as we note The largest income elasticity was in Asia Pacific (3.02), and the reason is that a large part of Asian countries have achieved rapid growth in their incomes in recent years, which necessitated a greater increase in demand for crude oil, and the United States of America ranks second in terms of high income elasticity (2.3), it is known that the American economy is one of the largest economies in the world and is a large producer and consumer of crude oil, while it was less flexible (0.57) than the share of Latin America, and the reason for this may be due to the crises that the Latin American countries were exposed to during the research period, which was reflected in the weakness of Its economic performance and the weakness of its annual income, thus reducing the demand for crude oil [19]. On the other hand, we find that the price elasticity of crude oil was weak for all regions of the world, and the majority carried the expected negative sign, and the largest price elasticity was for Asia, and it amounted to (-0.11), and the least price elasticity in the United States of America reached (-0.009), and these results confirm the weak response The rise in prices in crude oil over the consumed quantities of oil, and this result confirms the pivotal role that oil possesses as one of the main sources of energy in the regions of the world in the short and medium-term.

5.6 DIAGNOSTIC CHECKING TESTS

To test efficiency and consistency of the estimates we apply the normality , autocorrelation and Panel Cross-section Heteroskedasticity. The results show that The residuals have a normal distribution, There is no autocorrelation problem , However, we find that the residuals suffer from heterogeneous variance, because we dealt with deferent region [20].

Table 6. diagnostic checking tests

	test	Statistic	Prob.
Normality	Jarque-Bera	3.380	0.184
No cross-section dependence (correlation) in residuals	Pesaran CD	0.614	0.539
Panel Cross-section Heteroskedasticity LR	Likelihood ratio	1294.647	0.000

Source: Researchers finding using EViews 10

1.CONCLUSIONS

This paper aimed to estimate the elasticity of oil for both income and price demand in 10 countries and regions of the world for the period from 1993 to 2020, by employing the DOLS and PMG/ARDL methodology, and these methods depend on the dynamic modern econometric approaches, and the results of the DOLS methodology showed that income affects directly on the demand for oil in most countries and regions of the world, and the total elasticity is less than one, which means that the income elasticity is weak and this is mainly due to the orientations of many countries of the world towards alternative energy such as clean energy such as solar and wind energy and policies to combat climate change, as well as To increase global production of crude oil, and the results of price flexibility show the inverse relationship, although it is weak, and this is an indication that oil prices do not exercise a significant impact on the global oil demand. As for the results of the PMG/ARDL methodology, it was more in line with the economic logic, if the long-term income elasticity showed a weak positive direct effect, as well as the case with price elasticity, and these results are consistent with the results of the DOLS methodology, and the important conclusion is that the demand for crude oil has recently become It is not only affected by income and prices, but by important factors, including the increasing trend towards clean energy sources and policies directed at climate change and the increase in oil production greater than the volume of demand for it.

Funding

None

ACKNOLEDGEMENT

The author we would like to thank the reviewers for their valuable contribution in the publication of this paper.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

REFRENCES:

[1] Watkins, S. (1960). *An Insider's Guide To Trading The Global Oil Market The Key Players In The Global Oil Market :*

[2] Baffes, J., Kose, M. A., Ohnsorge, F., & Stocker, M. (2015). The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2624398

[3] Duccio, C. (2013). Alfred Marshall on the Theory of Capital. *MPRA Paper*, *35423*, 601–626.

[4] Galbraith, J. K. (2016). *Paul Samuelson on His 90th Birthday*. https://doi.org/10.1177/0569434515626857

[5] Fibich, G., Gavious, A., & Lowengart, O. (2005). The dynamics of price elasticity of demand in the presence of reference price effects. *Journal of the Academy of Marketing Science*, *33*(1), 66–78. https://doi.org/10.1177/0092070304267108

[6] Breitung, J. (2015). *the Local Power of Some Unit Root Test for Panel Data*. Advances Econometrics, *15*, 161–177.. ; Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

[7] Narayan, P. K., Smyth, R., & Prasad, A. (2007). Electricity consumption in G7 countries: A panel cointegration analysis of residential demand elasticities. *Energy Policy*, *35*(9), 4485–4494. https://doi.org/10.1016/j.enpol.2007.03.018; Hlouskova, J., & Wagner, M. (2006). The performance of panel unit root and stationarity tests: Results from a large-scale simulation study. *Econometric Reviews*, *25*(1), 85–116.

[8] Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

[9] Asteriou, D., & Hall, S. G. (2006). *Applied Economics, A Modern Approach using Eview and Microfit*.

[10] Kao, C., & Chiang, M. H. (2000). On the estimation and inference of a cointegrated regression in panel data. In *Advances in Econometrics* (Vol. 15). https://doi.org/10.1016/S0731-9053(00)15007-8

[11] Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, *20*(3), 597–625. https://doi.org/10.1017/S0266466604203073

[12] Vector, I. C., Processes, A., Author, I., & Saikkonen, P. (2016). *Infinite-Order Cointegrated Vector Autoregressive Processes : Estimation and Inference Author (s): Pentti Saikkonen and Helmut Lütkepohl Published by : Cambridge University Press Stable URL : http://www.jstor.org/stable/3532913 Accessed : 28-02-2016 21*. *12*(5), 814–844.

[13] Pesaran, M. H., Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association*, *94*(446), 621–634. https://doi.org/10.1080/01621459.1999.10474156

[14] Eggert, W., & Haufler, A. (1999). Capital taxation and production efficiency in an open economy. *Economics Letters*, *62*(1), 85–90. https://doi.org/10.1016/s0165-1765(98)00214-6

[15] Fahad, A. Y., Battal, A. H., & Al-ogaidi, A. M. (2021). *Impacts Of COVID-19 Pandemic On Main Economic Indicators*. Webology, *18*(5), 1426–1450.

[16] Hsiao C, Appelbe TW, Dineen CR (1993) A general framework for panel data analysis—with an application to Canadian customer dialed long distance service. Journal of Econometrics 59:63–86, https://doi.org/10.1016/0304-4076(93)90039-8

[17] Dargay, J., Gately, D., & Sommer, M. (2007). Vehicle Ownership and Income Growth, Worldwide: 1960-2030. *The Energy Journal*, *28*(4), 143–170.

[18] Alam, M. Q., & Alam, M. S. (2016). The determinants of inflation in India: The bounds test analysis. *International Journal of Economics and Financial Issues*, *6*(2), 544–550.

[19] James H. Stock, Mark W. Watson (1993). A Simple estimator of cointegrating vectors in higher order integrated systems, Econometrica, Vol. 61, No. 4 (July, 1993), 783-820

[20] Samuelson, P., & Nordhaus, W. (2010). Economics 19th Edition. Douglas Reiner, Quebecor World Versailles Inc., 10/12 New Baskerville.

Appendix 1 ARDL Bounds Test

ARDL Bounds Test		
Africa	30.28302***	
Americas	9.740191***	
Of which USA	10.17678***	
Asia Pacific	18.27319***	
China	13.40136***	
Europe	6.357063***	
India	7.778973***	
Latin America	9.268578***	
Middle East	18.95696***	
Other Asia	4.138523**	
	Critical Value Bounds	
Significance	I0 Bound	I1 Bound
10%	3.17	4.14
5%	3.79	4.85
2.5%	4.41	5.52
1%	5.15	6.36

*** statistical significance at 1 percent level
** statistical significance at 5 percent level
* statistical significance at 10 percent level

Source: Researchers finding using EViews 10