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An Approach To Study The Effects of GBP/USD Exchange Rate and Gold Prices on Brent Oil Prices Using Autoregressive Distributed Lag (ARDL)

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ABSTRACT

The Autoregressive Distributed Lag (ARDL) is possible when cointegration analysis is applied to experimentally to shape the relationship between the variables without considering the regressors are stationary at its first difference or level, there is an integration of order one or both of the variables are mixed. Being based on one equation framework is a benefit of using the ARDL model, in order to take sufficient lags' number and directing process data generation process in a modelling framework that goes from general to specific. The aim of this study is to focus on the trend of the relation between the GBP/USD rate and Brent Oil prices, which is done through the adoption of dependent variable which the oil price and the independent variable which is the dollar exchange rate. Another target of the research is to show the relationship between gold price and oil prices. The result shows that there are a number of likely influenced variable through by which the dollar-pound rate has effects on the demand and supply of oil as a result of its prices. That is done through the analysis of the relations between the variables of the study. Moreover, correlation coefficient values are given that there exists a positive explanatory correlation between the variables of the study. On the whole, there exists a positive long-term equilibrium relation between the GBP/USD exchange rate, price of oil and price of gold. Any change in the exchange rate of GBP/USD is causing the changes in prices of Brent oil. Consequently, the results are consistent with and not consistent with other researches that show opposite relationship.

1. INTRODUCTION

According to [1] the ARDL model is thought to be a standard squares regression where both explanatory and response variables fall behind as regressors. Despite of its usage in both econometrics and statistics for tens of years, the ARDL model only became popular recently as a way to examine cointegration between variables which were extended by [2] after their suggestion by[3].There are many techniques for cointegration in the literature, among those [4] consider the expression of "cointegration" as a technique being used for the reflection of the equilibrium long-term among the variables which tend to meet with time, while ARDL approach is known to be the newest technique of cointegration to check equilibrium and dynamic relations between explanatory and response variables. Some instances cointegration techniques are those which [2][5] supposed. The usage of the ARDL model started as they realized that the variables to be studied are found to be non-stationary and there is an integration of the same order between them, after that there is a possibility to study the cointegration relationship (i.e the likelihood the variables move with each other) by the ARDL approach between explanatory and response variables in long-term.

The adoption of ARDL is possible when cointegration analysis is applied to experimentally to shape the relationship between the variables without considering the regressors are stationary at its first difference or level, there is an integration of order one or both of the variables are mixed [2]. Being based on one equation framework is a benefit of using the ARDL model, in order to take sufficient lags' number and directing process data generation process in a modelling framework that goes from general to specific[6]. In addition to all these, the argument by [7] states that the cointegration test of Johansen needs a big sample in order to get reasonable, although, it indicates that ARDL approach works better with a the sample of a small [8].

1.1 Objective of the research

The aim of this study is to focus on the trend of the relation between the GBP/USD rate and Brent Oil prices, which is done through the adoption of dependent variable which the oil price and the independent variable which is the dollar exchange rate. Another target of the research is to show the relationship between gold price and oil prices.

1.2 Hypothesis

- There exists a correlation between the prices of Gold and the prices Brent oil.
- There is a correlation between the exchange rate of GBP/USD and the prices Brent oil.
- There exists a relation that is sourced from the prices of gold toward the prices of Brent oil.
- Any increase or decrease in the exchange rate of GBP/USD will cause important changes in the prices of Brent oil in the long run.
- There exists a relation that is sourced from the exchange rate of GBP/USD towards THE prices of Brent oil.

2. LITERATURE REVIEW

The study conducted by [9] which is one of the most recent studies using ARDL, searches for another treatment for spurious regression, that is caused by the unit root and analysis of cointegration, these are frequently used for the treatment of spurious regression but because of some specification as, innovation process distribution, structural breaks choice of the deterministic part and autoregressive lag length choice, they are not stable. The research which for the most part concentrated on Monte Carlo simulations, discovered that the main reason of spurious regression is caused by variables that are missing in the values of lag, which the treatment is an alternative method that leads us to the variable that is missing and as a result to ARDL model. As a conclusion the study comes up with the confirmation that we can benefit from ARDL as different way to the spurious regression problem.

[10] which benefited from using a small T (number of time periods) and a big N (number of cross section data), concentrated on a single estimation equation of ARDL model from panel

data. While Micro panel data on individuals and firms are represented by the mentioned structure, to acquire consistent parameter estimates, the estimation ways don't need the time dimension to be bigger. Single equation models with internal independent variables and dynamics autoregressive, the estimators of Generalized Method of Moments (GMM) which were extensively used in this situation, are the focus eras of the study. Two instances are put into the discussion as a simple autoregressive model for rates of investment and a basic production function, using firm-level panel data. The conclusion from the paper is that to get consistent parameter estimation an extensive range of microeconomic applications, we can benefit from using GMM estimators. Although these estimators may face biases of large finite sample, when the estimator of consistent GMM is compared to an estimator of a simple kind such as the level Ordinary Least Square, these biases can be detected and prevented in experimental studies [11]. Financial and economic with statistics indicators are the three topics that most ARDL research is done about. The research which studies the long-term relation between the rate of inflation and its factors in Iran using ARDL is done by [12]. The study concluded that the most statistically significant reasons affecting the rate of inflation in the country are the liquidity, inflation (imported), the exchange rate and the GDP. The ARDL cointegration technique is used by[13] to study the relation between the Chinese share market and the rate of exchange. The conclusion of the study is that the stock market is affected positively by the rate of exchange and money supply. The approach of ARDL bounds testing was used by[14] to investigate relations between the rates of inflation and the reserves of foreign exchange in Pakistan, for almost half a century (from 1960 to 2007). The paper concluded that a long-term cointegrating relation between the rates of inflation and the reserves of foreign exchange in the country.[15] implemented research using the approach of ARDL bounds testing for a period of 28 years from 1982 to 2010 to study how volatility of oil prices affects the rate of inflation in Taiwan. The conclusion of the paper indicates to a relation between the two but of a long-term and in addition to that the paper concluded any global increase in the prices of oil causes inflation merely in the long-term.

3. METHODS AND MATERIALS

3.1 Data Collection

The data to investigate the impact of the Exchange Rate of GBP/ USD and the prices of Gold on the prices of oil from 2000 to 2022 on a monthly basis in the world were collected from various sources such as the Exchange Rate of GBP/ USD (E.X): the exchange rate of the United States. Dollar against a Great Britain currency (Pound), the prices of Brent oil (B.O.): Brent Oil barrel price. (G.P) Price of Gold per ounce in US dollars (USD/OZ). The response and explanatory variables are compounded monthly and based on nominal values (01/2000-08/2022). The data were collected from [16].

3.2 Methods

An ARDL methodology is being adopted to investigate the long-term relation between the response and explanatory variables under examination [2]. The time series not being integrated from the second degree or more I (2) is the only criterion that makes this test different from the other tests of its kind. Although, the method of self-regression accepts chains of stability at the levels of I (0) and I (1) or both together. Prior to the equation analysis, we should be ensured that the variables under study are stationary; which means our variables do not have unit root problem. Later on, the co-integration test of (ARDL) is implemented while estimation of the model in short and long term and the test of Granger causality are done. Lastly, the results of the analysis are shown as followings.

The Autoregressive Distributed Lag model adopts the following form:

$$\ln BO_t=\delta_0+\sum_{k=1}^{n} \delta_{1k} \Delta\ln BO_{t-k}+\sum_{k=1}^{n} \delta_{2k} \Delta\ln ED_{t-k}+\sum_{k=1}^{n} \delta_{3k} \Delta\ln GP_{t-k}+\pi_1 \ln BO_{t-1}+\pi_2 \ln ED_{t-1}+\pi_3 \ln GP_{t-1}+\varepsilon t \qquad \ldots\ldots\ldots\ldots\ldots\ldots.. \quad (1)$$

Δ shows variables differences of the first level, the response variable parameter (B.O.) decelerated for a single period to the left side of the equation; π indicates long-run relations parameter, (δ) represents first differences parameters for the short period where random stroke errors and segment are represented by ε and δ0 respectively.

The first step in the ARDL bounds testing approach is to estimate equation (1) by Ordinary Least Squares (OLS) in order to test for the existence of a long-run relationship among the variables by conducting an F-test. Estimation of the above equation is the first step of the testing approach which is done by (OLS) so that we can test if there is long-term relation between the variables through applying an F-test to determine the lagged levels coefficients for response and explanatory variables in joint significance.

$H_0: \pi_1=\pi_2=\pi_3=0$

$H_1: \pi_1\neq\pi_2\neq\pi_3\neq 0$.

A test for co-integration is provided by two asymptotic critical values bounds when the explanatory variables are I(d), while ($0\leq d\leq 1$): the smallest value representing the regressors are I(0), and the largest value representing the regressors are I(1). Regardless, the integration orders of the time series null hypothesis is being rejected if the F-statistic value is greater than the upper critical value. On the other hand, null hypothesis is being accepted if the F-statistic value is smaller than the lower critical value. Finally, the result is inconclusive if the F-statistic value is in the range between the upper and lower critical values [17].

3.3 Stationarity Tests

The Dickey-Fuller test is one of the most common tests to examine the unit root test. The simplest formula of this test dates back to 1979 named as the test of Simple Dickey- Fuller (D.F.), estimating the Autoregressive Model of first-order AR (1) is the basis of the test as follows:

$\Delta X_t=\alpha x_{(t-1)}+\varepsilon_t$ ……………. (2)

Where ε_t shows the stochastic error with the following conditions supposedly:

$E(\varepsilon_t)=0, var(\varepsilon_t)=E(X_t-\mu)=\sigma^2, Cov(\varepsilon_i,\varepsilon_j)=0\ i\neq j$, e_t follows normal distribution

According to [18] under the above assumptions a suitable estimation technique is the least square estimation as the estimation is straightforward.

If the value of α equals to 1, the variable (X_t) has a unit root and its non-stationary then it is called the White Noise Error Term. If we subtract ($X_{(t-1)}$) from both sides of the above equation, it will be as follows:

$\Delta X_t=(\alpha-1)X_{(t-1)}+\varepsilon_t$ …….. (3)

The equation becomes as follows if we set ($\alpha-1 = p$)

$\Delta X_t=pX_{(t-1)}+\varepsilon_t$

Using OLS method for estimation, the three models become as follows:

$\Delta X_t=pX_{(t-1)}+\varepsilon_t$ ……… (4)

$\Delta X_t=\theta_0+pX_{(t-1)}+\varepsilon_t$ ……… (5)

$\Delta X_t=\theta_0+\theta_1+pX_{(t-1)}+\varepsilon_t$ …….. (6)

All the above have been done so we can test the following null hypothesis:

Null hypothesis H0: $p = 0$ (1)

Alternative hypothesis H1: $p \neq 0$ (2)

The time series is non-stationary at the level if $P = 0$ is calculated to be $\Delta x_t=\varepsilon_t$.

If the conditions for the alternative hypothesis are applied, the time is called stationary and it is of order I (0). Taking the first difference or second differences we can make the time series stationary. That is when the time series under study is said to be stationary.

In case of a Serial Correlation, the Dickey-Fuller test in its simple formula is not reliable and appropriate to examine if the time series is stationary or not. That is when the test of Augmented Dickey-Fuller should be used which is based on estimating of the following models:

$\Delta X_t=pX_{(t-1)}+\sum_{j=2}^{p}\varphi_j \Delta pX_{(t-j+1)}+\varepsilon_t$…….. (7)

$\Delta X_t=\theta_0+pX_{(t-1)}+\sum_{j=2}^{p}\varphi_j \Delta pX_{(t-j+1)}+\varepsilon_t$ ………. (8)

$\Delta X_t=\theta_0+\theta_1 t+pX_{(t-1)}+\sum_{(j=2)}^{p} [\varphi_j \Delta pX_{(t-j+1)}] +\varepsilon_t$…….. (9)

Firstly, the optimal lag (p) is chosen which leads to the removal of the self-correlation with stochastic errors using specific tolls in statistics. The two criteria of Akaik and Schwarz are the most significant of these tools.

However, there will be a false significance of the parameters if there exist a too short lag length that is caused by the information which is not explained. The Akaike information criteria (AIC) which is a statistical method is often used to determine the lags number. This method is a way of balancing between the underfitting case and overfitting case. As it does not depend on accepting or rejecting the null hypothesis, the Akaike information criteria are not a classic hypothesis test.

It depends on scoring system and choosing the "most suitable" model as follows:

$AIC=-2\log(L)+2m$ …… (10)

Where m represents the number of parameters and the estimated model likelihood function of log value. Hannan Quinn criterion (HQ) and Bayesian Information criterion (BIC) which are the other frequent lag selection criteria are used as followings:

$BIC=-2\log(L)+ m \log(n)$ ……. (11)

$HQ=-2\log(L)+ 2m \log (\log(n))$ ……. (12)

Where n denotes the number of observations or the sample size.

4. RESULTS AND DISCUSSION

The description of the main statistics measurement such as mean and standard deviation etc. for the variables are shown in table 1:

Table1: Main descriptive statistics

Variables	Abbreviation	Mean	Standard Deviation	Maximum	Minimum
Oil Price	BO	4.0766	0.49690	4.94	2.95
Gold Price	GP	6.7857	6.3077	7.59	5.56
Exchange Rate	EX	1.2021	0.16044	1.58	0.85

As shown in the table (1) that the mean and standard deviation of oil price are (4.0766, 4.94) respectively, (6.76857, 6.3077) for gold price and (1.2021, 0.16044) for exchange rate.

Table 2: Correlation matrix of variables

Variables	Abbreviation	BO	GP	EX
Oil Price	BO	1	0.733**	0.721**
Gold Price	GP	0.733**	1	0.416**
Exchange Rate	EX	0.721**	0.416**	1

****** significance with alpha equals 0.01.

Table 2 indicates that there is a positive correlation between the rate if exchange and the price of oil with statistically significance because p-value of it were less than 0.05.

There is a moderate correlation coefficient between the price of oil and the rate of exchange with statistically significance and almost approximately high correlation between gold price and oil and price. According to the result of correlation coefficient is that the problem of multi-collinearity does not exist among explanatory variables because the result for all were less than 0.08.

4.1 Unit root tests

The conduction of this test is needed to make sure that response and explanatory variables are not integrated of second difference I (2), The time series not being integrated from the second degree or more I (2) is the only criterion that makes this test different from the other tests of its kind. Although, the method of self-regression accepts chains of stability at the levels of I (0) and I (1) or both together [2]. The unit tests of response and explanatory variables show in the table 3 and table 4. Table 3 illustrates the test of Augmented Dickey-Fuller result and table 4 illustrates the test of Phillips-Perron result. The null hypothesis is that the time series a stationary in level and first difference or both. Result shows that the null hypothesis accepts because p-value was less than 0.05 in first difference. The results are similar with the test of Augmented Dickey-Fuller and the cointegration tests of ARDL can be proceed with these tests because response and explanatory variable are stationary in first difference.

Table 3: Unit root test of Augmented Dickey-Fuller

Variable	ADF Test Stat*	1%level**	5% level	P-value
At level (0)				
Ln BO	-2.297963	-3.454443	-2.872041	0.8299
Ln EX	-1.689155	-3.454353	-2.872001	0.4449
Ln GP	-0.753304	-3.454353	-2.872001	0.8299
1st Difference I(1)				
Ln BO	-12.39297	-3.45444	-2.872041	0.000
Ln EX	-16.30667	-3.45444	-2.872047	0.000
Ln Gp	-18.63172	-3.45444	-2.872041	0.000

Table 4: Unit root test of Augmented Dickey-Fuller - Phillips-Perron

Variable	ADF Test Stat*	1%level**	5% level	P-value
At level (0)				
Ln BO	-2.037016	-3.454443	-2.872001	0.2709
Ln EX	-1.791431	-3.454353	-2.872001	0.3844
Ln GP	-0.651940	-3.454353	-2.872001	0.8552
1st Difference I(1)				
Ln BO	-12.39471	-3.45444	-2.872041	0.000
Ln EX	-16.31323	-3.45444	-2.872041	0.000
Ln Gp	-18.71194	-3.45444	-2.872041	0.000

4.2 Normality test

It is indicated in the table (5) that the value of Jarque- Bera equals to 1.430124 and the probability of it is 0.491024 which is greater than the common alpha 0.05. Thus, residuals are normally distributed.

Table 5: Normality test

Mean	Std.Dev	Skewness	Kurtosis	Jarque-Bera	Probability
3.69	0.05321	-0.251234	4.21354	1.430124	0.491024

4.3 Correlation LM Test

It is clear in the table (6) that the null hypothesis (there is no serial correlation exist in the model) were rejected because p-value of Obs*R-squared were less than the common alpha 0.05 and accepts the alternative hypothesis (there is serial correlation exist in the model). In conclusion, there is serial correlation exist in the model.

Table 6: Breusch-Godfrey Serial Correlation LM Test

F-statistics	3.01243	Prob (2, 261)	0.1425
Obs*R-squared	11.9824	Prob.Chi-Square (2)	0.00597

4.4 Heteroskedasticity Tets

It is clear in the table (7) that there is no heteroskedasticity problem exists in the model because the prob. Chi squar (6) of Obs*R-squared were greater than 0.05.

Table 7: Breusch-Pagan-Godfrey

F-statistics	1.69576	Prob (6, 263)	0.2096
Obs*R-squared	12.98542	Prob.Chi-Square (6)	0.2199
Scaled explained SS	3.74521	Prob.Chi-Square (6)	0.9487

4.5 Lag Selection

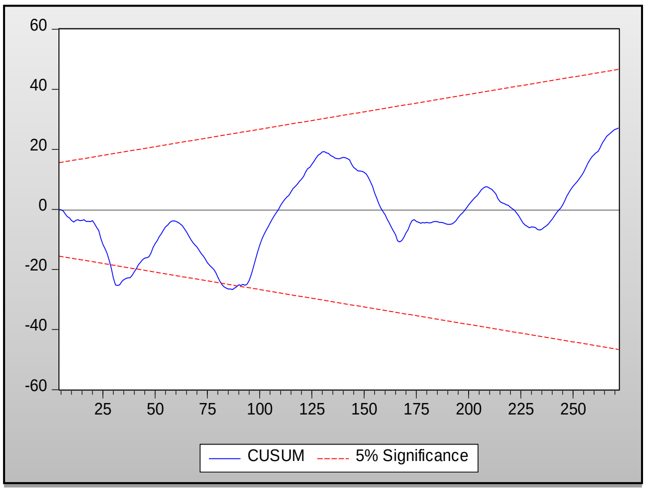
After we have found the order of integrating, two- steps of cointegration of ARDL procedure is applied. In the first stage, likelihood ratio (LR) criteria, SBC (Schwarz Bayesian Criterion) and AIC are used to determine the length of optimal lag of vector autoregressive. Table 8 illustrates the optimal lag chosen for vector autoregressive, it is crucial that we can choose high enough lag to make sure that the optimal order is not exceeding it. Five vector autoregressive (VAR (p)) p = 0,1,2,3,4 models are expected from 2000 to 2022.
Because of minimization of the lost in the degree of freedom and the selection of smallest possible lag length, Schwarz Bayesian Criterion is for lag selection. As a result, lags two are selected in this research.

Table 8: Selection of Optimal Lag

Lags	LR	FPE	AIC	SC	HQ
0	NA	1498861	22.7385	22.77448	22.75018
1	2505.751	104.6792	13.16452	13.38694	13.22984
2	33.46569*	98.38573*	13.10249*	13.38694	13.21679
3	6.040995	102.8597	13.55325	13.55325	13.31018
4	7.206401	107.0148	13.18636	13.71462	13.39863

4.6 Stability Tests

According to [19] the CUSUM square (CUSUMSQ) test and the cumulative sum of recursive residuals (CUSUM) are applied to study the stability of the model. CUSUM test helps to indicate if there is systematic change in the regression coefficients. The parameters of the null hypothesis are stable and the ones of the alternative hypothesis are not. Consequently, in the beginning of the figure, the blue line is not within the red lines but later it is within the two red lines, which implies that the parameters are going to be stable. CUSUM of square test helps in indicating if there is a sudden change in the coefficients of regression. If we interpret that, in the beginning the blue line was within red lines and then it was within the red line, it means at first that the null hypothesis were accepted and the alternative hypothesis is rejected, but it was going to be stable because the blue line was going be within the red lines.



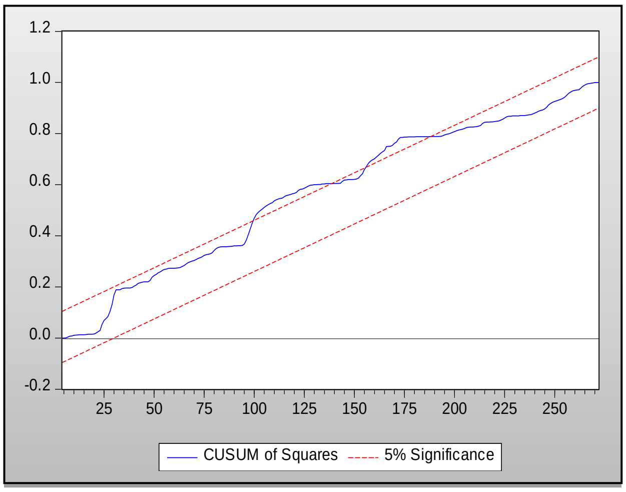


Figure1: CUSUM Test **Figure2:** CUSUM of Squares Test

4.7 Co-integration Rank

- H0: There exists no co-integration relationship (no long- term relationship between response and explanatory variables)
- H1: There exists at least one co-integration (long- term relationship between response and explanatory variables)

Table 9: Unrestricted Co-integration

Hypothesized	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.081792	30.00113	29.79707	0.0474
At most 1	0.016753	7.217613	15.49471	0.5525
At most 2	0.010086	2.706767	3.841466	0.0999
Hypothesized	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None*	0.081792	22.78351	21.13162	0.0290
At most 1	0.016753	4.510847	14.26460	0.8019
At most 2	0.010086	2.706767	3.841466	0.0999

Table (9) displays the Johnson test in co-intergration test under 95% of confidence level. As the p-value was greater than the common alpha 0.05 or the value of statistics was more than the common alpha 0.05, the null hypothesis There exists no co-integration relationship (no long- term relationship between response and explanatory variables) is rejected and the alternative hypothesis There exists at least one co-integration (long- term relationship between response and explanatory variables) is being accepted. Consequently, there is long-run relation among the response and explanatory variables.

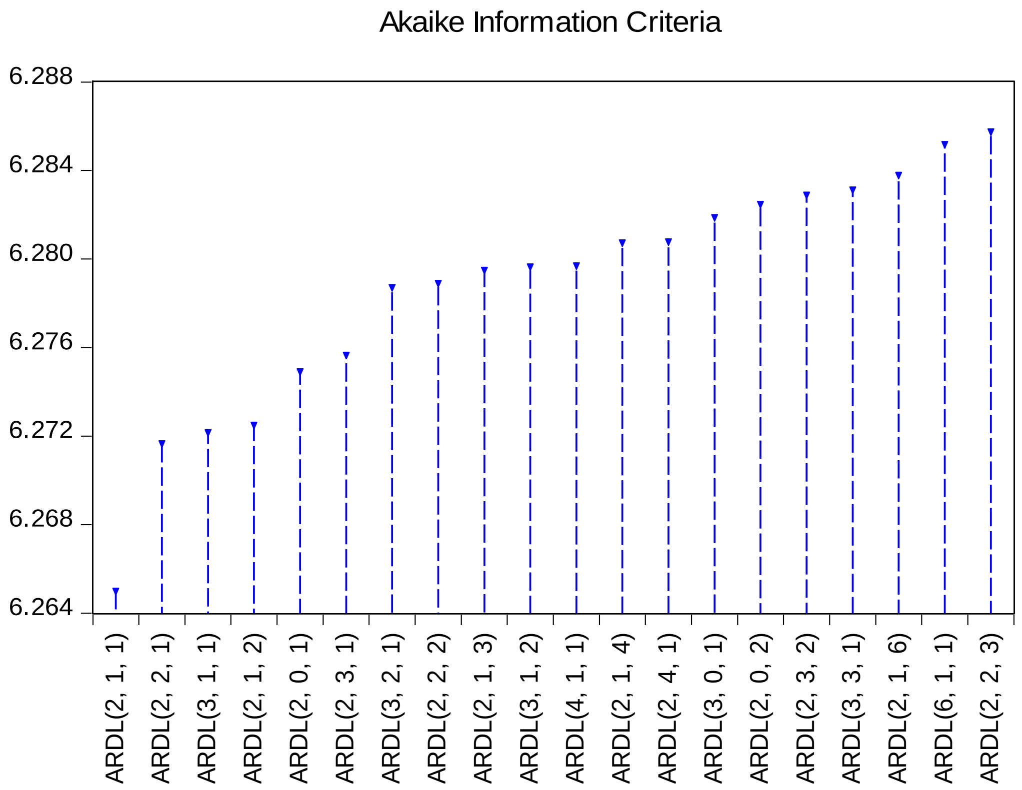


Figure 3: Akaike information criteria appropriate the test of lag periods

From Table 5 and Figure 3, it is obvious that the most suitable models using AIC are ARDL (2, 1, 1) for Oil price, LGold price, LGBP/USD, respectively.

4.8 Co-integration test of ARDL

After establishing the long-run cointegration relation, the estimation of equation (2) was done. Table 10 shows the results acquired by normalizing oil prices in the long term. We can notice significant effects of independent variables lags on the oil price. First and second lag of oil price have a statistically significant impact at 1% confidence level. First and second lag of gold price have a statistically significant impact on oil price too which shows as a highly statistically significant impact from first and second lag of exchange rate of LGBP/USD.
In addition, the negative value of gold price and exchange rate in the first lag means that those have a negative impact on oil price in the first lag.

Table 10: ARDL co-integration test

Variable	Coefficient	Std. Error	T- Statistic	Prob.*
LBO(-1)	1.109304	0.058376	19.00283	0.0000
LBO(-2)	-0.205508	0.059017	-3.482171	0.0006
LGP	0.255899	0.120368	2.125970	0.0185
LGP(-1)	-0.218031	0.110245	-1.977660	0.0411
LEX	0.820413	0.198258	3.810541	0.0002
LEX(-1)	-0.628727	0.196142	-3.205468	0.0015
C	-0.019040	0.070195	-0.271250	0.8764
R-squared	0.961099	Mean dependent var	65.80085	
Adjusted R-squared	0.961099	S.D. dependent var	29.61642	
S.E. of regression	5.563761	Akaike info criterion	6.296010	
Sum squared resid	8141.281	Schwarz criterion	6.389302	
Log likelihood	-842.9613	Hannan-Quinn criter	6.333472	
F-statistic	1226.534	Durbin-Watson stat	1.982265	
Prob (F-statistic)	0.0000			

4.9 F-Bounds Test

As a result, we have reached an establishment that none of the selected series I(2) or above and the optimal lag order determination, long run cointegration presence test was done using bounds test. Table 11 illustrates the results of ARDL bound test of cointegration. F-statistics is greater (6.503655) than critical value of the upper bound, according to [2], (at 1% significance level) is 5.0. Therefore, there are enough reasons for the rejection of the null hypothesis which states no long-term relation at 1% significance level and probably there exists cointegration between variables under investigation.

Table 11: Bound test results

Test statistics	Value	K
F-statistic	6.503655	2
Significance	**Critical value bounds I0 Bound**	**I1 Bound**
10%	2.53	3.25
5%	3.2	3.77
2.5%	3.45	4.28
1%	4.23	4.99

4.10 Long-Run Relationship

Table 12 displays the long-run result. The Gold price coefficient is statistically significant with a value of 0.393679, which implies that an increase with the rate of 1% in supply of relative gold price, causes an increase of 0.393619 in oil price in the long term. The relative coefficient of GBP/USD exchange rate is 1.317447 and it is significant, that indicates an increase of 1% in the relative GBP/USD exchange rate results in an increase of 1.317447 appreciation in oil price in the long term.

Table 12: Estimated long run coefficients

Variables	**Coefficient**	**Long Run Coefficient Standard Error**	**t-Statistics**	**Prob.**
LGP	0.393619	0.110915	3.548827	0.0005
LEX	1.317447	0.446136	2.953016	0.0034
C	-0.197918	0.720404	-0.274732	0.7837

4.11 Estimations of ARDL-based error correction model

After estimating parameters of long-term, the estimation of short-term parameters is needed, specifically for the estimation of error correction model. In Table 13, it was found that error correction model parameters are significant at level of 1% and 5%.

Short term and long term signals are positive as well excluding the parameter of error correction which equals to −0.096204.

It was found that the statistically significance is at level 1% with a negative signal leads to an increase in the long term equilibrium relation. There is no mechanism for error correction in the model and the parameter is used to measure the returning speed in the long term to an equilibrium position. The returning speed to equilibrium position equals to −0.096204.

Table 13: Estimations result of Long Run from ARDL-based error correction model

Selected Model	**ARDL (2, 1, 1)**			
Variable	**Coefficient**	**Std. Error**	**T-statistic**	**Prob.**
D(LBO(-1))	0.205508	0.058424	3.517545	0.0000
D(LGP)	0.255899	0.137735	2.857907	0.0165
D(LEX)	0.755470	0.194697	3.880234	0.0001
CointEq (-1)	-0.096204	0.024762	-3.885118	0.0001

4.12 Granger Causality test

Table 14 shows a summary of a unidirectional causal relation that was seen between the oil price and GBP/USD exchange rate, which is significant at 1.83%, as the p-value is smaller than 5%. It illustrates that the exchange rate of GBP/USD has effects on of Brent oil price, but price of Brent oil has no effect on the GBP/USD exchange rate.

Table 14: Granger causality test of Brent oil price and GBP/USD

Null Hypothesis	**Obs**	**F-Statistic**	**Prob**
L EX does not Granger Cause LBO	269	4.05930	0.0183
LBO does not Granger Cause LEX		0.55357	0.5756

Table 15 shows a summary of a one-way causal relationship that was seen between the oil price and Gold price, which is statistically significant at 1.92%, as the p-value is less than 5%. It shows that Gold price has effects on the price of Brent oil, but price of Brent oil has no effect on the gold price.

Table 15: Granger causality test of Brent oil price and Gold price

Null Hypothesis	**Obs**	**F-Statistic**	**Prob**
L GP does not Granger Cause LBO	269	3.87116	0.0192
LBO does not Granger Cause LGP		0.45639	0.6347

Table 16 shows a summary of a one-way causal relationship that was found between the GBP/USD and Gold price, which is not significant, because the p-value is more than 5%. It shows that Gold price has no effect on LGBP/USD has no effect on Gold price.

Table 16: Granger causality test of Gold price and GBP/USD

Null Hypothesis	Obs	F-Statistic	Prob
L EX does not Granger Cause LGP	269	0.16014	0.8521
LGP does not Granger Cause LEX		0.12959	0.8785

5. CONCLUSION

In this research, we tried to investigate the nature of the relation between the GBP/USD exchange rate, the Brent oil price, and the gold price. Result shows that there are several possible channels influenced through which the dollar-pound rate affects in one way or another oil supply and demand and as a result oil prices. That is done through the analysis of the relations between study variables. Moreover, correlation coefficient values are given that there exists a positive explanatory correlation between the variables of the study. We have found a causal relationship between the gold price and the Brent oil price, which is unidirectional. This relationship demonstrates that the gold price has effects on the price of Brent oil, but not vice versa. In addition, when the exchange rate varies it leads to changes in oil prices. This is a unidirectional relationship from the GBP/USA towards oil prices which was shown by the Granger causality test. Finally, In this study, there is a co-integration relationship between the interpreting variables and the Brent oil price in US dollars per barrel (B.O), represented in GBP/USD Exchange Rate and the Gold Price in US dollars per ounce (G.P.). On the whole, there exists a positive long-term equilibrium relation between the GBP/USD exchange rate, price of oil and price of gold. Any change in the exchange rate of GBP/USD is causing the changes in prices of Brent oil. Consequently, the results are consistent with and not consistent with other researches that show opposite relationship.

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