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EMPIRICAL ANALYSIS OF MACROECONOMIC FACTORS AND CRUDE OIL PRICES IN GHANA

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Abstract

A time series and country specific variables from 1980 to 2011 was used to conduct the empirical analysis of macroeconomic factors with respect to crude oil prices in Ghana. A robust methodology rooted in Granger causality test was conducted. Generally the study results indicate that there was significant long run relationship among GDPGR and the other macroeconomic variables such that long run movements in LOP and REER significantly explained movements in the GDPGR. Also, there was significant short run relationship between GDPGR and the other macroeconomic variables in such a way that short run movements in the world crude oil price significantly explained movements in the GDPGR with short run movement in the REER explaining movements in the GDPGR.

Keywords: Crude oil prices, Macroeconomic factors, Cointegration, Economy, Ghana

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INTRODUCTION

Crude oil prices are very important in analyzing macroeconomic factors. Blanchard and Gali (2007) empirically investigated the effects of oil price shocks on macroeconomic variables, and concluded that oil price changes have significant effects on inflation rate. Oil prices are quoted in foreign currencies because hydrocarbons are considered to be international commodities whose prices are determined among others by global demand and supply forces. This provides the opportunity to manage disparity between the local currencies and foreign currencies in which crude oil is quoted so that macroeconomic volatility is controlled (Abbas & Nikbakht, 2009). Crude oil prices have been identified to contribute to exchange rate depreciation especially in net crude oil importing countries.

The hypotheses guiding the study are as follows:

1. Null hypothesis (H_o): There was no significant long-run relationship between the oil prices and the other macroeconomic variables.
2. Null hypothesis (Ho): There was no significant short-run relationship between the world crude oil prices and the other macroeconomic variables.
3. Null hypothesis (Ho): The world crude oil prices do not significantly granger cause the other macroeconomic variables.

METHODOLOGICAL DISCUSSION

A time series and country specific variables from 1980 to 2011 was used to conduct the study. Crude oil prices are very sensitive to macroeconomic outturn in Ghana. The series was very pronounced in the 1970s but the study could not capture data from the 1970s the real effective exchange rate for periods prior to 1980 were not available. The model below was specified for the determination of both the long and short run relationship among the variables:

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{m} \alpha_2 \, \Delta Y_{t-i} + \sum_{i=0}^{m} \alpha_3 \, \Delta X_{t-i} + \alpha_4 Y_{t-1} + \alpha_5 X_{t-1} + \eta_t \quad \dots \dots (1)$$

Where X represent the endogenous variable and Y the exogenous variable under consideration, Δ is the lag operator of X and Y at time *t*, α_2, α_3 represent the short-run dynamic of the model while α_4 α_5 represent the long run dynamic term. This specification of the model allows for both long and short run relationship to be determined in a single equation at the same time. The five variables used in the estimation for the cointegration, were put together and reformulated in the model below:

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$$\begin{bmatrix} \Delta GDPGR \\ \Delta REER \\ \Delta CPI \end{bmatrix} = \begin{bmatrix} \beta_{01} \\ \beta_{02} \\ \beta_{03} \end{bmatrix} + \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{bmatrix} t + \sum_{i=1}^{n} \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{15} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} & \alpha_{25} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} & \alpha_{35} \end{bmatrix}$$

$$\begin{bmatrix} \Delta GDPGR_{t=i} \\ \Delta REER_{t=i} \\ \Delta CPI_{t=i} \\ \Delta LOP_{t=i} \\ \Delta GCF_{t=i} \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \end{bmatrix} \begin{bmatrix} GDPGR_{t-1} \\ REER_{t-1} \\ CPI_{t-1} \\ LOP_{t-1} \\ GCF_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

Where Δ is the first difference of the variables, $\beta_{i=01,\ 02,\ 03}$ were the constant of the cointegration model, $\alpha_{i=11,\ 12\ \ldots\ldots}\ \alpha_{35}$ were the coefficients of the first difference term, $\beta_{\ i=11,\ 12,\ldots\ldots,}\ \beta_{35}$ were the coefficients of the lag variables and $\mu_{i=1t,\ 2t,\ 3t}$ were the error terms. In order to investigate the existence of cointegration when GDPGR is the dependent variable instead of REER, CPI, LOP and GCF as independent variables, the following hypotheses were stated:

$$H_0: \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = \beta_{15} = 0$$

$$H_A: \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = \beta_{15} \neq 0.$$

To verify the presence of cointegration using REER as the dependent variables and the GDPGR, CPI, LOP and GCF as independent variables, the following hypotheses were stated:

$$H_0: \beta_{21} = \beta_{22} = \beta_{23} = \beta_{24} = \beta_{25} = 0$$

$$H_A: \beta_{21} = \beta_{22} = \beta_{23} = \beta_{24} = \beta_{25} \neq 0.$$

When finding the existence of cointegration using CPI as the dependent variable and GDPGR, REER, LOP and GCF as the independent variables, the following hypotheses were stated:

$$H_0: \beta_{31} = \beta_{32} = \beta_{33} = \beta_{34} = \beta_{35} = 0$$

$$H_A: \beta_{31} = \beta_{32} = \beta_{33} = \beta_{34} = \beta_{35} \neq 0.$$

According to Pesaran et al., (2001), a study would reject the null hypotheses under any of the three circumstances if the F-statistic calculated for the group was greater than the pre-determined upper critical bound tabulated. They also indicate that the work would fail to reject the null hypotheses of no cointegration if the calculated F-statics for the group was less than the predetermined lower critical bound as tabulated. However, there was inconclusive result should the F-statistic calculated for the group lie between the predetermined lower and upper critical bounds.

The specification below was used to determined the long run coefficients

$$\begin{bmatrix} GDPGR \\ REER \\ CPI \end{bmatrix} \begin{bmatrix} \beta_{01} \\ \beta_{02} \\ \beta_{03} \end{bmatrix} + \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{bmatrix} t + \sum_{i=1}^{n} \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \end{bmatrix}$$

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$$\begin{bmatrix} GDPGR_{t-1} \\ REER_{t-1} \\ CPI_{t-1} \\ LOP_{t-1} \\ GCF_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{bmatrix} \quad \ldots\ldots..(3)$$

Where $\beta_{i=01,\ 02,\ 03}$ represent the constant terms, $\beta_{i=11,\ 12,\ldots\ldots,}$ β_{35} were the coefficients of the lag variables and $\mu_{i=1t,\ 2t,\ 3t}$ were the error terms of the respective rows.

After the determination of the long run coefficients, the short run coefficients were determined. The determination of the coefficients of the short run estimates and the speed of adjustment toward equilibrium if there had been any disequilibrium situation.

$$\begin{bmatrix} \Delta GDPGR \\ \Delta REER \\ \Delta CPI \end{bmatrix} = \begin{bmatrix} \beta_{01} \\ \beta_{02} \\ \beta_{03} \end{bmatrix} + \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{bmatrix} t + \sum {n \atop i\,=\,1} \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \end{bmatrix}$$

$$\begin{bmatrix} \Delta GDPGR_{t=1} \\ \Delta REER_{t=1} \\ \Delta CPI_{t=1} \\ \Delta LOP_{t=1} \\ \Delta GCF_{t=1} \end{bmatrix} + \begin{bmatrix} ECM_{1t-1} \\ ECM_{2t-1} \\ ECM_{3t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{bmatrix} \quad \ldots\ldots\ldots\ldots(4)$$

Where $\beta_{i=01,\ 02,\ 03}$ represent the constant terms, $\beta_{i=11,\ 12,\ldots\ldots,}$ β_{35} were the coefficients of the first difference of the variables, $\mu_{i=1t,\ 2t,\ 3t}$ were the error terms of the respective rows and the ECM showed the error correction term.

Granger Causality Test

Gujarati (2003) cointegrated variables must have an error correction representation with the implication that if non-stationary series are cointegrated, then one of the series must granger cause the other or both. The granger causality test was conducted to determine the nature of causal relationship among the variables. In doing that, the only dependent variable that was cointegrated with the other independent variables, was used as dependent variable in this analysis and shown in equations below:

$$\Delta Y_t = \mu_0 + \sum_{i-1}^{p} \beta_{1i} \Delta Y_{t-i} + \sum_{i-0}^{p} \emptyset_{1i} \Delta X_{t-i} + \xi_{1i} ECT_{t-1} + \nu_t \ldots\ldots\ldots.(5)$$

$$\Delta X_t = \mu_0 + \sum_{i-1}^{p} \beta_{2i} \Delta X_{t-i} + \sum_{i-0}^{p} \emptyset_{2i} \Delta X_{t-i} + \xi_{2i} ECT_{t-1} + \upsilon_t \ldots\ldots(6)$$

Where ΔY and ΔX are non-stationary dependent selected in equation 5 and 6 and independent variables in equation 5 and 6, ECT is the error correction term, ξ_{1i} and ξ_{2i} are the speed of adjustments. *p* is the optimal lag order while the subscripts *t* and *t-i* denoted the current and lagged values. If the series were not cointegrated, the error correction terms would not appear in equations 5 and 6. In order to find out whether the independent variables like REER, CPI, LOP and GCF represented by *X,* granger-causes the dependent variable GDPGR represented

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by Y in equation 5, the study tested the null hypothesis by examining the joint significance of the lagged dynamic terms:

$H_0 : \phi_{1i} = 0$, implying that the independent variable (*X*) does not granger-cause the dependent variable (*Y*), against the alternative hypothesis that

$H_0 : \phi_{1i} \neq 0$, implying that the independent variable (*X*) granger-cause the dependent variable(*Y*).

Also, to find out whether the independent variable (*Y*) granger-cause the dependent variable(*X*) in equation 6, the study tested the null hypothesis by examining the significance of the lagged dynamic term:

$H_0 : \phi_{2i} = 0$, implying that the independent variable (*Y*) do not granger-cause the dependent variable (*X*), against the alternative hypothesis that

$H_0 : \phi_{2i} \neq 0$, implying that the independent variable (*Y*) granger-cause the dependent variable (*X*).

Using the standard F-test or Wald statistic, four possibilities existed: First of which is to reject the null hypothesis in equation 5 but failing to reject the null in equation 5 at the same time implies unidirectional causality running from *X* to *Y.* Second is to reject the null hypothesis in equation 6 but at the same time failing to reject the null in equation 6 implies unidirectional causality running from *Y* to *X*. Third is to simultaneously reject the two null hypotheses for bi-directional causality. Fourth, is the simultaneous failure to reject the two null hypotheses indicates independence or no causality between the variables of interest.

EMPIRICAL ANALYSIS

Table 1: Descriptive Statistics (Observations 32)

STATISTIC	GDPGR	REER	CPI	LOP	GCF
MEAN	4.349063	384.3176	30.09375	1.824648	17.27383
MEDIAN	4.745000	129.6433	24.72000	1.777682	18.14943
MAXIMUM	14.39000	3578.972	122.8700	2.341320	29.00214
MINIMUM	-6.920000	91.48667	8.730000	1.455906	3.377636
STD. DEV.	3.826253	734.2627	26.75597	0.240587	7.770649
SKEWNESS	-0.845409	3.252326	2.409673	0.660622	-0.276082
KURTOSIS	5.820637	13.23628	8.589326	2.431658	1.944876
JARQUE-BERA	14.41982	196.1225	72.62223	2.758261	1.890898
PROBABILITY	0.000739	0.000000	0.000000	0.251797	0.388505
SUM	139.1700	12298.16	963.0000	58.38875	552.7624
SUM SQ. DEV.	453.8467	16713393	22192.33	1.794349	1871.873

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The descriptive statistics indicate relatively small spread (Standard deviation) of the GDPGR with distribution skewed to the left in line with the finding by (Lind, Marchal & Mason, 2000). In consonance with the proposition by Gujarat (2003), the distribution of GDPGR was peaked while the Jarque-Bera (JB) statistic indicated that the series was not normally distributed at the probability (p) value of almost zero.

Also, Table 1 indicated that REER had a mean value of 384.32, showing a very high average value while median for the same variable was 129.6, implying that the value central to the REER series was high. It further shows that the maximum and the minimum values respectively for REER were 3579 and 91 as portrayed throughout the study period. The REER values were positive and were widely spread and the distribution was positively skewed and peaked. The JB statistics of the REER indicated that the distribution was not normal at a probability of approximately zero. The analysis for the CPI shows that the mean and the median were 30 and 25 respectively. The highest value registered by the CPI was 123 while the least value for the study period was 9. This implied that the values were widely spread with standard deviation of 27. The distribution shows right sided and peaked CPI series over the study period while the JB statistics of 72.6 indicates that the distribution was not normal at the probability of nearly zero. On the other hand, the mean and the median of the LOP were both close to but the highest value of the LOP was 2.3 with 1.5 the lowest. There was low spread of the distribution at 0.2 and the LOP distribution were positively distributed and peaked while the JB statistic was 2.7 which indicated that the series were not normally distributed at a probability of 0.25. The GCF produced a mean of 18 and the median of 18. The maximum and the minimum values were 29 and 3.4 respectively with spread of 7.8. The coefficient of skewness of -0.28 indicates that the distribution of the series of the GCF was left sided with very low peak while the JB statistics was 1.9 at a probability of 0.3885.

Correlation Matrix

In order to find out whether there were linear relationship among the variables and the nature of the relationship among the series and the likelihood of the problem of multicollinearity in the regression results, the correlation matrix was formulated. This conforms to the argument by Gujarati (2006) that if the correlation matrix has been taken and the correlation coefficient between or among any series is about 0.8 and above, there would be the likelihood of the problem of multicollinearity arising. High individual pairwise correlation coefficient would negatively influence the partial correlation coefficient.

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Table 2: Correlation Matrix of the Variables

	GDPGR	REER	CPI	LOP	GCF
GDPGR	1.000				
REER	-0.7568	1.000			
CPI	-0.6147	0.7432	1.000		
LOP	0.2666	0.0514	-0.1236	1.000	
GCF	0.4600	-0.6306	-0.4963	0.0997	1.000

Source: Computed by the authors using Eviews 5.1

Table 2 shows the strength of the relationship existing among the variables. From the table there was positive linear correlation between LOP and the GDPGR and the coefficient of correlation is 0.2666. This means that although, there was positive relationship between LOP and the GDPGR, the relation was weak. Also, there was positive linear correlation between LOP and REER. The correlation coefficient of 0.0514 indicates that although there was positive linear relationship between LOP and REER, the relationship was very weak. Similarly, there was positive linear correlation between LOP and GCF with correlation coefficient of 0.0997. However, LOP negatively correlated with the CPI with weak coefficient of correlation of -0.1236.

Table 3: Correlation Matrix of the First Difference of the Variables

	GDPGR	REER	CPI	LOP	GCF
GDPGR	1.000				
REER	0.6367	1.000			
CPI	-0.0200	0.03280	1.000		
LOP	-0.6534	-0.2292	0.1744	1.000	
GCF	-0.1256	-0.0121	-0.1948	-0.1561	1.000

Source: Computed by the authors using Eviews 5.1

This shows the correlation matrix of the first difference of LOP, GDPGR, REER, CPI and GCF. The purpose was to determine whether changes in the LOP would have any relationship with changes in other macroeconomic variables. There was negative correlation between the first difference of LOP and the first difference of GDPGR, REER and CPI. While the coefficient of correlation between LOP and GDPGR was strong negative and that between LOP and REER was (-0.2292) weak negative linear relationship. Further, LOP and GCF were negatively correlated and weak (-0.1561). However, there was weak positive correlation between the LOP and the CPI (0.1744) . Tables 2 and 3, indicate the problem of multicollinearity is not evidenced in line with the explanation by (Gujarati, 2003).

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Test for Significance of Correlation Coefficients

According to Bluman (2004) and Lind et al (2000) a test of significant is conducted in order to give a conclusion on the nature of the relationship existing among the variables. In doing this, they proposed that the null hypothesis should be stated. Thereafter, the critical level be identified using a chosen α level followed by the computation of the test statistic. The test statistic is compared with the critical value at the chosen α level after which decision is made by comparing the test statistic calculated and the critical value. The decision rule is that, accept the null hypothesis that there is no significant relationship between the LOP and other macroeconomic variables if the test statistic calculated fall within the critical bound at the chosen α level. Otherwise, reject the null hypothesis and accept the alternative hypothesis should the test statistic be greater or outside the critical region. Following Bluman (2004) and Lind et al (2000), the researcher hypothesised that there was no significant linear relationship between LOP and other macroeconomic variables. The chosen α level was 0.05 and the results are shown in Tables 5 and 6.

Table 5: Test for Significance of Correlation Coefficient of Variables at Level

Measure	t-test	Critical value
$r_{LOP\ GDPGR}$	1.500	1.960
$r_{LOP\ REER}$	0.2800	1.960
$r_{LOP\ CPI}$	-0.6820	1.960
$r_{LOP\ GCF}$	0.5485	1.960

Source: Computed by authors

Table 5 indicates the critical value at 0.05 α- level. The critical values are adopted from the t-distribution testing the hypothesis that, there was no significant linear relationship between LOP and the selected macroeconomic indicators. A comparison between the test statistics in and the critical value at an α- level of 0.05, showed that the test statistics fell within the chosen critical value at an α level of 0.05 with significant statistical evidence to accept the null hypothesis of no linear relationship between the LOP and other macroeconomic variable. This also confirms that the relationship in the correlation matrix is by chance.

Table 6: Test for Significant of Correlation Coefficient of the Variables at First Difference

Measure	t- test	Critical value
$r_{DLOP\ DGDPGR}$	-4.728	1.960
$r_{DLOP\ DREER}$	-1.29	1.960
$r_{DLOP\ DCPI}$	0.97	1.960
$r_{DLOP\ DGCF}$	-0.866	1.960

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The t-statistics computed and the critical value at 0.05 α-level adopted from t-distribution table in Bluman (2004). The hypothesis guiding this test was that, there was no significant linear relationship between changes in the LOP and changes in the other macroeconomic variables. To make decision, the t-tests were compared with the respective critical values at an α-level of 0.05. Following Bluman (2004) there was enough statistical evidence to accepted the null hypothesis of no linear correlation between the first difference of LOP and those of REER, CPI and GCF. On the contrary, by comparing the t-test of the correlation coefficient of the first difference of the LOP and the GDPGR, it is therefore deduced that the t-test (4.728) was greater than the critical value (1.960) at 0.05 α- level hence there was enough statistical evidence to conclude that there was linear relationship between the first difference of LOP and GDPGR and that the relationship was not as a result of chance.

Unit Root Tests Results

The unit root test was conducted to find out the stochastic characteristic of the variables. Although the bounds test approach to cointegration does not necessitate the pretesting of the variables for unit root, it was however important to conduct the test to verify that the variables were not integrated of an order higher than one [I(1)]. Cointegration results were invalid if variables included in the model were integrated of order higher than unity (Ouatarra, 2004). Thus, the order of integration of variables was the driving purpose of the test and not to make the data stationary. The formal test to ascertain the order of integration of the variables was conducted using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The null hypothesis tested was that, the series were non- stationary. Table 7 reports the results of the unit root tests conducted using the ADF test and the PP test.

Table 7: Unit root test results

	ADF TEST RESULTS			**PP TEST RESULTS**		
Variables	p-Value	Lag length	Order	P-value	Band width	order
GDPGR	0.0555	2	0	0.5810	8	1
DGDPGR	0.0001	1	0	0.000	8	0
REER	0.1037	0	1	0.1317	4	1
DREER	0.000	0	0	0.0000	13	0
CPI	0.0013	0	0	0.0013	2	0
DCPI	0.000	0	0	0.0001	9	0
LOP	0.8730	0	0	0.8880	1	1
DLOP	0.000	0	0	0.000	0	0
GCF	0.2763	0	1	0.3841	30	1
DGCF	0.0001	2	0	0.0000	15	0

Source: Computed by Authors using Eviews 5.1

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Table 7 significantly indicated that the highest order with which the series attained stationarity was with order one I[1]; which was with the REER and the GCF under the ADF test. Under the PP-test the highest order stationarity was also unity, which was experienced by GDPGR, REER, LOP and the GCF variables. This was an indication that the highest order of stationarity was unity, demonstrating that the study would not break down if it went ahead with the cointegration test and the estimation of both long- and short –run coefficients. The PP test was conducted to confirm the estimates of the ADF test. Stationarity of at most I(1) means that the variables had the tendency of co-moving to equilibrium. But as to whether it was in the long or short run, it was not capable of indicating it hence, the need for the conduct of the cointegration test.

Cointegration Results

Testing for the existence of long-run as well as shot-run equilibrium relationships among the variables within the framework of the bounds testing approach to cointegration was paramount to establish relationship between changes in world crude prices and the selected macroeconomic variables.

Given a relatively small sample size and the use of annual data, a lag length of 1 was used in the bounds test in line with Pesaran and Shin (1997) who suggested a maximum lag length of 1 for annual data in the bounds test approach. After the lag length was determined, the F test statistic computed within the framework of the Unrestricted Error Correction Model (UECM) was compared with the upper and lower critical values in Pesaran et al. (2001) under an α-level of 0.1.

The null hypothesis tested was that, there was non- existence (no cointegration) of long-run relationship among the variables (H_0: $\alpha_4 = \alpha_5 = 0$), which was for equation 4 and the null hypothesis for equation 4 was (β_0: $\beta_4 = \beta_5 = 0$), as against their alternative hypotheses. If the F-statistics was compared with the upper and the lower critical bound at a given α- level, the following conclusion could be made: If the F- value calculated was greater than the upper critical bound value at a given significant level, there was cointegration among the variables. Secondly, if the calculated F-value fell within the upper and the lower critical bound values, then, the result was inconclusive. Finally, if the calculated F-value was lower than the lower bound value, there was no cointegration. In the ARDL technique, cointegration was a show metric to the determination of the long- and short- run coefficients since the absence of cointegration would mean the discontinuation of the process of the determination of the long- and short- run relationships.

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Table 8: Results of Cointegration Test

ROW	DEP. VAR	F-STAT. (VALUE)	NO. REG. (K)(K)	BOUND CRITICAL VALUE		
				(%)	UPPER	LOWER
				10	3.59	2.53
1	GDPGR	5.1055*	6	5	4.00	2.87
				1	3.60	4.90
				10	3.59	2.53
2	CPI	1.5722	6	5	4.00	2.87
				1	3.60	4.90
				10	3.59	2.53
3	REER	2.4555	6	5	4.00	2.87
				1	3.60	4.90

Source: Computed by Authors using Microfit Version 4.1 developed by Pesaran and Pesaran (1997).

Note * implies significant at the 10 per cent level.

The first row of Table 8 showed GDPGR as the dependent variable and the F-value is 5.1055. Comparing the F-value and its respective upper and lower bound at an α-level of 0.1, it was apparent that the F-value for GDPGR (5.1055) was significantly higher than all the upper bounds. According to Pesaran and Pesaran (1997), test rejected the null hypothesis of no cointegration and accepted the alternate hypothesis of the presence of cointegration. The acceptance of cointegration means that there was both long and short run relationship between GDPGR as dependent variable and the REER, CPI, LOP and GCF as independent variables. Which also confirmed results by both Adam and Tweneboah (2008) in the “Implications of Oil Price Shocks for Monetary Policy in Ghana when they conducted a Vector Error Correction Model” that the general performance of the country proxied by the GDP was cointegrated with other macroeconomic variables considered in their studies and that of Tatom (2008) oil prices have that both long and short term effects on the economy.

Where CPI and REER were used as dependent variables as against the rest as independent variable, their F-values as against their upper and lower bounds showed that the F-values of CPI and REER were significantly far lower than their respective lower bounds. Based on this, and following Pesaran and Pesaran (1997), the study accepted the null hypothesis of no cointegration between CPI and REER as dependent variables and their respective regressors. The absence of cointegration means there was no long run or short run equilibrium relationship between the dependent variable and its independent variables. As a result of this, the long run estimates and the short run dynamics using GDPGR as the dependent variables were estimated against REER, LOP, CPI, and GCF as independent variables.

Table 9: Long Run Coefficients with GDPGR as the Dependent Variable

Regressor	Coefficient	Standard Error	T-Ratio	Probability
CPI	-0.00255	0.01801	-0.1413	0.889
REER	-0.00541***	0.8436E-3	-6.4099	0.000
REER(-1)	0.003169***	0.8453E-3	3.7494	0.000
LOP	4.4743***	0.74555	4.0014	0.000
GCF	-0.05225	0.06079	-0.08593	0.398
	Diagnostic Tests			
Test Statistics	LM Version		F Version	
Serial Correlation	CHSQ(1)=0.8473[0.357]		F(1,24)=0.67446[0.420]	
Functional Form	CHSQ(1)= 0.3050[0.581]		F(1,24)=0.2385[0.630]	
Normality	CHSQ(2)= 18.455[0.000]		Not applicable	
Heteroscedasticity	CHSQ(1)= 3.2558[0.071]		F(1, 29)= 3.4031[0.075]	

Source: Computed by Authors using Microfit Version 4.1 developed by Pesaran and Pesaran (1997).

Note: *** implies significant at the 1, per cent significant level.

Although the cointegration test conducted confirmed those conducted by Adam and Tweneboah (2008), Hamilton (1983) and Hasanov (2010), but there was a departure in terms of the coefficients of the estimates. While they found inverse relationship between GDP and the oil price, the present work found direct relationship between the GDPGR and the LOP. This could be attributable to the choice of variables, the study period, the country considered and social and political factors. It was as a result of similar departure that Paiva (2008) provided that the impact of oil price on inflation has declined over period and that the impact of crude oil prices on GDPGR has changed.

Table 10: Short Run Dynamics with DGDPGR as Dependent Variable

Variable	Coefficient	Standard Error	T-Ratio	Probability
DREER	-0.005407***	0.8436E-3	-6.4099	0.000
DLOP	4.7342***	1.1614	4.0763	0.000
DCPI	-0.002545	0.01801	-0.1413	0.889
DGCF	-0.052251	0.060790	-0.8595	0.9398
ECM(-1)	-1.0000	0.00	-	
R-Squared	**0.7244**	R-Bar-Squared	0.66930	
S.E. of Regression	**1.8516**	F-stat. F(4, 26) 16.4281[0.000]		
Mean of Dependent Variable	**0.44903**	S.D. of Dependent Variable 3.2198		
Residual Sum of Squares	**85.7111**	Equation Log-likelihood -59.7506		
Akaike Info. Criterion	**-65.7506**	Schwarz Bayesian Criterion -70.0525		
DW-statistic	**1.3312**			

Source: Computed by Author using Microfit Version 4.1 developed by Pesaran and Pesaran (1997).

Note: *** implies significant at the 1, significant level.

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From table 10, both the first difference of REER and LOP were significant in explaining movements in the first difference in the GDPGR in Ghana within the study period. At 1% significance level, a percentage increase in the first difference of the REER led to a fall in the DGDPGR by about 0.0054 units, all things being equal. Also one percent increase in the first difference of the LOP at 1% significant level was capable of inducing about a 5% rise in the DGDPGR in Ghana. This again, is an indication that a certain level of rise in LOP did not negatively affect the growth of the economy. The first difference of the other variables was not significant in explaining movements in the DGDPGR. The coefficient of the error term which is negative implies that the model was capable of reverting to equilibrium after a period of distortion. The error correction equation is stated as follows;

ECM = GDPGR +0.00224REER +0.06457CPI - 4.4743LOP +0.05225GCF

Having identified cointegration relationship among variable does not mean causal relationship is determined hence the Granger (Engle & Granger, 1987) approach was used. Basically, granger causality tests would give directions to the type of variables to manipulate in order to achieve specified result in an economy.

Granger Causality Test Results

Once there was cointegration between GDPGR and the other explanatory variables, there was the tendency of one variable pulling along the other to convergence. Pairwise Granger causality test was conducted on the variables to determine whether a variable granger caused the other. Thus, to find out whether the independent variable, REER, CPI, LOP or GCF granger-caused the dependent variable GDPGR, the joint significance of the lagged dynamic terms by testing the null hypothesis was examined:

$H_0 : \phi_{1i} = 0$, implying that the independent variable REER, CPI, LOP or GCF does not granger-caused the dependent variable GDPGR, against the alternative hypothesis that

$H_0 : \phi_{1i} \neq 0$, implying that the independent variable, REER, CPI LOP or GCF granger-caused the dependent variable, GDPGR. Also, to find out whether REER, CPI, LOP, or GCF granger-caused the GDPGR, significance of the lagged dynamic term by testing the null hypothesis was examined such that the $H_0 : \phi_{2i} = 0$, implying that the REER, CPI, LOP, or GCF do not granger-cause the GDPGR, against the alternative hypothesis that $H_0 : \phi_{2i} \neq 0$, implying that the REER, CPI, LOP, or GCF granger-caused the dependent variable GDPGR.

Using the standard F-test or Wald statistic, four possibilities existed: First, rejection of the null hypothesis in equation 8 but failing to reject the null hypothesis in equation 9 at the

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same time implies unidirectional causality running from REER, CPI, LOP, or GCF to GDPGR. Second, a rejection of the null hypothesis in equation 9 but at the same time failing to reject the null in equation 8 implies unidirectional causality running from GDPGR to REER, CPI, LOP, or GCF. Further to the above, simultaneous rejection of the two null hypotheses indicates bi-directional causality. Fourth, simultaneous failure to reject the two null hypotheses indicates independence or no causality between the variables of interest.

Table 11: Results of Granger Causality Test

Null Hypothesis	F-Statistic	Probability
REER does not Granger Cause GDPGR	4.41205**	0.01086
GDPGR does not Granger Cause REER	1.11666	0.37784
CPI does not Granger Cause GDPGR	1.33284	0.29400
GDPGR does not Granger Cause CPI	1.34529	0.28977
LOP does not Granger Cause GDPGR	7.94991***	0.00061
GDPGR does not Granger Cause LOP	1.21720	0.33635
GCF does not Granger Cause GDPGR	0.16188	0.95506
GDPGR does not Granger Cause GCF	0.21250	0.92825

Source: Computed by Authors using Eviews 5.1

The Granger causality test results in Table 11, shows that GDPGR was central to the analysis because it was the only dependent variable that had significantly established cointegration relationship among the explanatory variables. In view of this, the test result was run from the independent variables to the dependent variable (GDPGR) and from dependent variable to the independent variables in which the test results rejected at an alpha level of 0.05, the null hypothesis of no granger causality between the explanatory, REER, and the dependent variable, the GDPGR in the country; Implying that the REER granger caused the GDPGR such that for any case of distortion in the economy, a change in the REER would be capable of driving GDPGR back to its equilibrium. In finding out whether the dependent variable did same to the independent variable, it was established that, the null hypothesis of no granger causality between GDPGR and the REER was arrived at. This also indicated that GDPGR was not capable of pulling REER to equilibrium and for that matter; there was unidirectional causality from REER to GDPGR. With the LOP and the GDPGR, the null hypothesis of no granger causality was significantly rejected at 0.01 alpha level. This signifies that there was unidirectional causal relationship between the LOP and the GDPGR. Since the long run coefficients between LOP and GDPGR indicated a positive relationship between GDPGR and LOP and there was also a causal relationship between LOP and GDPGR, then slight increase in

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the LOP would be capable of stimulating economic growth in the country since any disequilibrium situation between LOP and GDPGR could be restored.

CONCLUSIONS

The results indicate that there was significant long run relationship among GDPGR and the other macroeconomic variables such that long run movements in LOP and REER significantly explained movements in the GDPGR. Also, there was significant short run relationship between GDPGR and the other macroeconomic variables in such a way that short run movements in the world crude oil price significantly explained movements in the GDPGR with short run movement in the REER explaining movements in the GDPGR. The study further concluded that there was direct relationship between changes in the world crude oil price and GDPGR implying that a small increase in the world crude oil price would lead to similar increase in the GDPGR. That there was significant causal relationship between LOP and GDPGR, and between REER and GDPGR and that the world crude oil prices were directly related to the GDPGR was inconsistent with those of Hamilton (1983), Adam and Tweneboah (2008) and Hasanov (2010) indicative of the influence of differences in countries, study period, economic policies undertaken and the status of the country whether it was crude oil importing country or exporting country or both. As a scope for further study, it is suggested that same study is conducted with more elongated data set and with refined crude prices since most economic activities are affected directly by ex-pump prices.

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