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Oil Price Shock and Macroeconomic Performance in Nigeria

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ABSTRACT
Nigeria is a mono-product economy, where the main export commodity is crude oil, changes in oil prices has implications for the Nigerian economy and, in particular, exchange rate movements. The latter is mostly important due to the double dilemma of being an oil exporting and oilimporting country, a situation that emerged in the last decade. The study examined the effects of oil price shock on macroeconomic performance in Nigeria using yearly data from the year 1979 to 2014. The theoretical framework of this study is based on unrestricted Vector Auto Regression model by Sims (1980). The models are used to estimate the relationship between oil price changes,inflation rate, Gross Domestic Product and real exchange rate. Unit root tests, Johansen co-integration technique, variance decomposition test, granger casualty test andVector Auto Regression Mechanism was used to examine the speed of adjustment of the variables from the short run dynamics to the long run. It was observed that a proportionate change in oil price leads to a more than proportionate change in real exchange rate, interest rate and Gross Domestic Product in Nigeria. Nigeria government should diversify from the Oil sector to other sectors of the economy so that Crude oil will no longer be the mainstay of the economy and frequent changes in crude oil price will not influence exchange rate volatility significantly in Nigeria.
Keywords: Oil price, Macroeconomic variable, VAR etc

1. INTRODUCTION

Before the discovery of oil in Nigeria, agriculture was the main source of Nigeria revenue. In 1960 and 1966, agriculture contributed about 58percent to the country's Gross Domestic Product (GDP) and employed over 60percent of the workforce. Nigeria was the world's largest producer of palm products, producing 64 percent of the world's palm kernel and 30 percent of the palm oil. Nigeria was also the second largest producer of peanuts, producing 40 percent of the world's peanuts and 27 percent of the world's peanut oil. In addition, Nigeria was among the top cocoa and cotton producers. This situation began to change drastically in the 1970s with the discovery of crude oil in Nigeria. The share of agricultural products in total exports has plummeted from over 70 per cent in 1960. The decline was largely due to the phenomenal rise of oil shipments, for example, 3.8 percent in 2001 to 4.25 percent in 2002 and up to 7.40 percent in 2006. It was 6.30 percent in 2008 and 5.90 percent in 2009, 4.00 percent in 2012, 2.61 percent in 2013 and grew by 6.28 percent in the Q4 of 2014 (Aigbokhan 2001).

The price of oilhas witnessed profound fluctuations and this has implication for the performances of macroeconomic variables, posing great challenges for policy making both fiscal and monetary. According to Awe (2002), crude oil price has increased on averages from US $25 per barrel in 2002 to US $55 per barrel in 2004, an increase in petroleum price tend to have a contractionary impact on world demand and growth in the short term. This steep upward trend in the price of crude oil in recent years reaching a record nominal high of US $147 in mid-2005 and a sharp drop to$87 in 2012, and $46 a barrel since 2014 to $41.95 2016. Nigeria is highly vulnerable to fluctuations in the international oil market despite being the 6th largest producer of oil in the world. This is so, given the fragile nature of the Nigeria macro economy and the heavy dependence on crude oil proceeds.

The study is motivated by the fact that Nigeria relies heavily on crude oil export revenues, that has several implications for the Nigerian economy, given the amount of wide swings in oil prices in the international oil market. It is, therefore, vital to analyze the effect of these fluctuations on the Nigeria macro economy and possibly the channels of transmission of anoil price shock to the Nigeria economy. It's understandable that some investors believed the conflict in Iraq will send oil prices skyrocketing. But, so far, oil prices haven't risen as much as is expected. The reason is simple, because the United States, while strategically interested in Iraq's future, is the beneficiary of a massive oil boom at home. This lessens the need for Iraqi oil, which has only begun to enter the market in earnest over the past couple of years. Plus, Iraq only produces about 3.2 million barrels per day. That's just not enough to affect global oil supplies in the longer term. Indeed, with U.S. oil production slated to grow and Saudi capacity still available, supplies haven't really been affected. Indeed, we don't expect this to change much, either. History has shown that oil price spikes are usually short lived and any bump the resource receives because of the situation in Iraq will be no different. Supply is adequate, and that's always what dictates the price of oil in the end.

The objectives of this paperare to investigate the effect of oil price shock on the real sector of Nigeria economy, examine the effect of oil price shocks on some macroeconomic variables like inflation and exchange rate, identify the channels through which the impact of oil price shocks transmit in the Nigerian economy.Thepaper is organizedinto five sections: introduction,review of theliterature, methodology, interpretation of results, and

conclusion.

2. Literature Review

2.1 Theoretical Framework

The macroeconomic responses to oil price shock in Nigeria can be explained using both supply and demand channels. According to economic theory, crude oil price change influence economic activity through both supply and demand channels. Supply side effects could be explained based on the fact that oil is an important input in production. Therefore, crude oil price increases reduce the demand for crude oil, decreasing theproductivity of other input factors which induce firm to lower output. For a neoclassical economist, the most natural way to think of crude oil is an input to the economy's production function. When an input gets more expensive, the profit-maximizing level of output declines. The standard way to present this argument (Hamilton 2005) is a simple Cobb-Douglas model of a representative form with the following production function:

Y = F (L, K, E)

Where L is labor, K is capital, and E is energy input with output Price 'P', wage 'W', capital rent 'r', and the nominal Price of energy 'PE'

π = R-C (Profit= revenue – cost)…… (1)
R=P.X (Revenue = price. Quantity)……..(2)
C=wL+rk+PEE (cost= Wage of labor+ capital rent+ price/cost of energy)……..(3)
π=P.X-wL-rK-PEE (Profit= price of product. Quantity minus wage of laborminus rent of capitalminus price/cost of energy or power supply)……..(4)

Supply Side Channel

Since oil is a factor of production in most sectors and industries, a rise in oil prices increases the enterprises' production costs and thus, induces contraction in output Patti and Ratti (2007). Given a firm's resource constraints, the increase in the prices of oil as an input of production reduces the quantity it can produce. Patti and Ratti (2007) added that an increase in input costs can drive down non-oil potential output supplied in the short run given existing capital stock and sticky wages. Moreover, workers and producers will counter the declines in their real wages and profit margins, putting upward pressure on unit labor costs and prices of finished goods and services.

Demand Side Channel

As presented earlier, oil price increases translate to higher production costs, leading to commodity price increases at which firms sell their products in the market. Higher commodity prices then translate to lower demand for goods and services, therefore decrease aggregate output and employment level. Furthermore, higher oil prices affect aggregate demand and consumption in the economy. The transfer of income and resources from an oil-importing to oil-exporting economies is projected to reduce worldwide demand as demand in the former is likely to decline more than it will rise in the latter (Patti and Ratti 2007). The resulting lower purchasing power of the oil-importing economy translates to a lower demand. Also, oil price shocks pose economic uncertainty on thefuture performance of the macro economy. People may postpone consumption and investment decisions until they see an improvement in the economic situation. In sum, an increase in oil prices causes a leftward shift in both the demand and supply curve, resulting in higher prices and lower output. Asymmetric responses to oil prices and the variables considered, such as GDP responses and inflation should be identified. Oil price shocks can lead to many costs as workers lose jobs in one sector or region and are only slowly reemployed in others; costs are masked by net changes in aggregate employment

Many researchers such Aliyu (2009), Hamilton (2005) etc have argued that the dangerous economic effects of oil-price hikes may be substantially stronger than the favorable economic effects of oil-price declines. All oil price changes can induce sectoral reallocations and create uncertainties about the returns to irreversible investments, but oil price decreases, unlike increases, have positive real income (terms-of-trade) effects that offset these negative impacts. Therefore, this implies that if oil price increases result to an economic recession, then oil price declines must cause an economic expansion with the same magnitude, although in reverse direction.

2.2 Empirical Study

Nkomo (2006) discovered that the oil price increases exerts a negative impact on economic growth in Japan and China and a positive impact on economic growth of Russia. Specifically, a 10% permanent increase in international oil prices is associated with a 5.16% growth in Russian GDP and a 1.07% decrease in Japanese GDP. On the one hand, an appreciation of the real exchange rate leads to a positive GDP growth in Russia and a negative GDP growth in Japan and China. Olomola (2006) used the variance decomposition approach to investigate and found that oil price shocks in Nigeria explained about 48% of the shocks to the real exchange rates in the 1st quarter, 33% in the 8th quarter, and about 32% in the 10th quarter. This confirms the fact that oil price shock affects the government monetary policy significantly through the exchange rate but that this effect may become insignificant as we move into through the 4th quarter, but by the 8th and 10th quarters oil price shock contributed about 10% and 17% respectively to change in the domestic money supply. Ayadi (2005) examined the effects of oil

production shocks on a net oil exporting country, Nigeria. The impact responses show that a positive oil production shock was followed byarise in output, reduction in inflation and a depreciation of the domestic currency. With the same methodology and set of variables (except that oil price replaces its level of production). He finds negligible responses of output, inflation and the real exchange rate following an oil price shock. Persistent oil price shocks could have severe macroeconomic implications, this including challenges for policy making i.e fiscal and monetary policies.

Edmund (2004) submits that economic factors are responsible for oil price fluctuation and shocks. These factors, according to him, covers theareas of production and consumption level of oil which includes US crude oil and product stock inventories, theunprecedented fast rate of industrialization in the Asian. Also, storage cost and availability of insurance cost, interest rates, inflation rate, transportation cost, currency rates, and market factors are no doubt responsible for oil price shocks.

Awe (2002), optimized a linear regression technique using Nigeria data for the period 1970 to 2000 and found that there is a positive relationship between the country's external reserves and crude oil prices. Olomola (2006) further reveals that oil price shocks may not influence the GDP at the initial stage, but as this shocks and fluctuation continue in the future, the more its impact would be evidenced in the output level, but the effect may not be that significant. However, on the price level (i.e. Inflation rates), it was found that oil price shockswere able to explain just a little of variability in the price level meaning that oil price shocks do not have remarkable effects on inflation rates in Nigeria. Previous empirical findings in other countries affirmed that oil price shocks do significantly affect output, inflation rate, exchange rate, money supply which are some of the variables used in this work to capture macroeconomic activities.

3. The Model

The study employs the use of Vector Autoregressive Technique to estimate the model. In econometric, there is the possibility of delay on the part of endogenous variable (y) to respond to changes in exogenous variables (x_1, x_2, $x_3 \ldots x_n$). To take care of such delay in response to changes (lag), it is necessary to use models that involve lags in exogenous variables, endogenous variables or both.

VAR was introduced by Sims (1980) and based on the idea that many macroeconomic variables and their movements are interrelated. Thereby modeling every endogenous variable in the system as a function of the lagged values of all the endogenous variables in the system. Thus, our unrestricted VAR in reduced form can be presented as:

$$\boldsymbol{\alpha_t} = \sum_{i=1}^{k} \mathbf{A_i}\, \boldsymbol{\alpha_{t-i}} + \mathbf{e_t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where;

α_t = is acolumn vector of observation at 't' of all the variables in the model, i.e.

α= ($RGDP_t$, COP_t, $REER_t$ INF_t)…………………………(2)

$RGDP_t$ = Real Gross domestic product

COP_t = Crude oil price

$REER_t$ = Real exchange rate of the naira

$INFL_t$ = Inflation rate

't'= time period.

e_t = Error term assumption to be normally distributed with zero mean and constant variance.

$\sum$ = Summation of exogenous variables at time't'

α_{t-i} = Lag of endogenous variables.

e_t = $N_1 - N_3$ are the impulse, innovations or shocks

A_i = $\alpha_1 - \alpha_3$ parameter to be estimated

4. Interpretation of Results

4.1 Unit Root Test Result

The result clearly shows that inflation rate is stationary at level. Meanwhile, crude oil price and real exchange rate were not stationary at first difference but integrated of the same order and they are all stationary.

4.2 Johansen Cointegration Test

The Johansen (1991) unrestricted cointegration test is used in this study. The statisticis used to test the existence of along-run relationship that exists between the dependent variable and its explanatory variables if it can be established that at least one cointegration equation exists between the variable under investigation, then a long-term equilibrium relationship exist between them. The likelihood ratio indicates two cointegrating equation(s) at 5% level of significance and one cointegrating equation at the 1%significant level. Whereas the eigenvalue test

indicates one cointegrating equation at 5% and 1% significant levels.

Based on the evidence , we can safely reject the null hypothesis (H_0) which says that there are no cointegrating vectors and conveniently accept the alternative hypothesis of the presence of cointegrating vectors. In other words, our conclusion is that a long run relationship exists among the variables that have entered our model.

4.3 Granger Causality Test

Granger causality tests are conducted to determine the direction of influence and causality between the variables in the VAR model.The result shows theunidirectional relationship between the real exchange rate and crude oil price with direction from real exchange rate to crude oil price, there is aunidirectional causal relationship between the real exchange rate and inflation rate with direction from real exchange rate to inflation rate.

4.4 Vector Auto-Regression

$$\mathbf{COP_{t-1}}=\boldsymbol{\pi_0}+\sum_{i=1}^{k+d}\boldsymbol{\pi_1}\mathbf{COP_{t-1}}+\sum_{i=1}^{k+d}\boldsymbol{\pi_2}\mathbf{RGDP_{t-1}}+\sum_{i=1}^{k+d}\boldsymbol{\pi_3}\mathbf{REER_{t-1}}+\sum_{i=1}^{k+d}\boldsymbol{\pi_4}\mathbf{INFL_{t-1}}$$

=-5.852419-0.169151COP+0.284547RGDP+0.132697REER+0.306582INFL

S.E= (7.61695) (0.41625) (0.39703) (0.08578) (0.16130)

T-stat= (-0.76834) (-0.40637) (0.71670) (1.54688) (1.90067)

$$\mathbf{COP_{t-2}}=\boldsymbol{\pi_0}+\sum_{i=1}^{k+d}\boldsymbol{\pi_1}\mathbf{COP_{t-2}}+\sum_{i=1}^{k+d}\boldsymbol{\pi_2}\mathbf{RGDP_{t-2}}+\sum_{i=1}^{k+d}\boldsymbol{\pi_3}\mathbf{REER_{t-2}}+\sum_{i=1}^{k+d}\boldsymbol{\pi_4}\mathbf{INFL_{t-2}}$$

=-5.82419+1.25001COP+0.483000RGDP+0.024467REER+0.0014225INFL

S.E= (7.61695) (0.54534) (0.12544) (0.07883) (0.11277)

T-stat= (-0.76834) (2.30133) (0.21544) (0.31039) (0.01264)

R-Squared=0.881760

Adjusted R-squared=0.793079

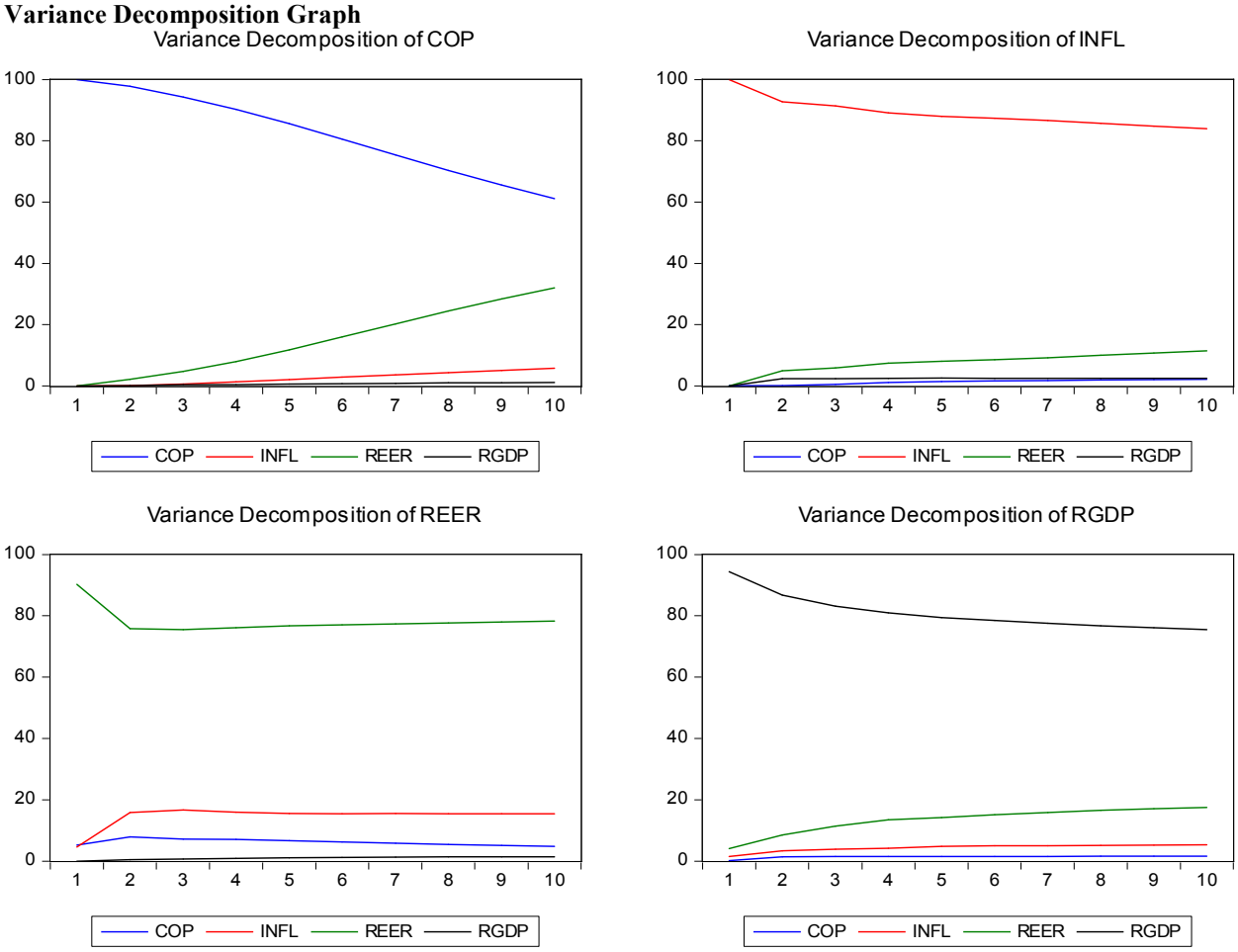
F-Statistics=9.94312

The result indicates that the real gross domestic product, real exchange rate, inflation rate were positive i.e. there is apositive relationship between the variables. Though is expected that the crude oil price shock will negatively affect the macroeconomics performance.Considering the statistical significant of the parameter, the result shows that the variables were greater than half of the coefficient of the variable except crude oil price. It was discovered that the R-squared is 88.17% which explained the variation in independent variable, while the remaining 11.83% explained variable outside the specified model. Hence from the analysis since F-calculated (F^c) =9.94312>F^t(2.56) therefore the estimation is linearly significant.

4.5 Variance Decomposition

Variance decomposition is used to aid the interpretation of a vector autoregression (VAR) once it has been fitted. It indicates the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance can be explained by the exogenous shocks to the other variables. Accordingly, we proceed to decompose the total variance of the forecast error in any of the dependent variables so as to determine how much of the variance is explained by the independent variable. The decomposition strongly depends on the ordering.

Variance Decomposition Graph



5. Conclusion

This study is carried out to investigate whether or not a dynamic relationship exists between crude oil price shocks and some macroeconomic variables and to examine the various oil price shocks with the implications on the Nigerian economy. All the variables in the literature survey provided some useful insights into the shock in oil price and macroeconomic performance in Nigeria. Based on the findings, it was established that the crude oil price shocks in Nigeria have a significant impact on dynamic variables such as inflation rate, real exchange rate, and gross domestic product. Crude oil price volatility is one of the major macroeconomic problems that confront the Nigerianeconomy today.It was observed that one phenomenon that has infected the price of crude oil in the global oil market which is also persistent but may die out quickly as we venture into the future is volatility or shocks.

The study further reveals that a little shock in the price of crude oil in the global oil market in the current period will produce a long-term effect on macroeconomic activities in Nigeria. In other words, oil price shock affects monetary and fiscal policies in Nigeria and have asignificant impact on government expenditure pattern and the growth of the gross domestic over the years in Nigeria. Finally, the paper observed that oil price shocks have asubstantial influence on output and inflation rate in Nigeria contrary to the research of Olomola (2006) who believed that oil price shock may not necessarily be inflationary.

Based on the findings made in this study, the paper recommends as follows:

The energy policy makers in Nigeria should have a better understanding of how the world's oil markets are likely to evolve in the future and how the total world demand for crude oil is likely to change in response to the changes in oil prices initiated by OPEC, and in response to future changes in price resulting from changing supplies in non-cartel countries.

A fall in the price of oil would decrease the level of GDP and worsen the economy, so it is essential to encourage diversification.As a means of cushioning the effect of oil price fluctuations in theeconomy. Nigeria should return to agriculture by providing technical input and financial support to the farmer.

Due to the failure of the Nigeria economy,after the period of the oil boom,it has been noticed that a fall in oil price brings about a fall in macroeconomic policies, mainly in terms of government expenditure and interest rate due to deflation.hence, it is, therefore,advisable for the government to establish strong macroeconomic policy.

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APPENDIX

JOHANSEN COINTEGRATION TEST

Date: 07/07/15 Time: 21:52
Sample (adjusted): 1981 2014
Included observations: 34 after adjustments
Trend assumption: Linear deterministic trend
Series: COP INFL REER RGDP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.877991	131.12003	94.15256	0.1893
At most 1	0.704009	70.11370	68.52107	0.5674
At most 2	0.422933	34.80830	47.21271	0.6581
At most 3	0.320532	18.864192	29.68146	0.5508

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.491551	22.99726	27.58434	0.1736
At most 1	0.290427	11.66512	21.13162	0.5809
At most 2	0.160819	5.961164	14.26460	0.6182
At most 3	0.010415	0.355956	3.841466	0.5508

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

COP	INFL	REER	RGDP
0.002261	-0.075319	-0.017570	0.150098
-0.010873	-0.046158	0.008072	-0.196305
-0.026284	-0.014314	0.022334	0.023981
-0.045494	0.002795	0.007310	-0.016463

Unrestricted Adjustment Coefficients (alpha):

D(COP)	-0.440656	-0.492334	3.871915	0.326657
D(INFL)	8.443369	5.279433	1.336920	-0.493326
D(REER)	5.056634	0.142455	-0.866579	2.134815
D(RGDP)	-3.294224	2.397971	-0.174159	0.205813

1 Cointegrating Equation(s): Log likelihood -525.1721

Normalized cointegrating coefficients (standard error in parentheses)

COP	INFL	REER	RGDP
1.000000	-33.30644	-7.769688	66.37406
	(7.55402)	(1.98591)	(20.7461)

Adjustment coefficients (standard error in parentheses)

D(COP)	-0.000996
	(0.00437)
D(INFL)	0.019094
	(0.00611)
D(REER)	0.011435
	(0.00925)
D(RGDP)	-0.007450
	(0.00254)

2 Cointegrating Equation(s): Log likelihood -519.3395

Normalized cointegrating coefficients (standard error in parentheses)

COP	INFL	REER	RGDP
1.000000	0.000000	-1.536884	23.51756
		(0.55142)	(6.26493)
0.000000	1.000000	0.187135	-1.286733
		(0.05051)	(0.57384)

Adjustment coefficients (standard error in parentheses)

D(COP)	0.004356	0.055915
	(0.02143)	(0.17046)
D(INFL)	-0.038307	-0.879632
	(0.02787)	(0.22168)
D(REER)	0.009886	-0.387436
	(0.04544)	(0.36145)
D(RGDP)	-0.033522	0.137433
	(0.01140)	(0.09072)

3 Cointegrating Equation(s): Log likelihood -516.3589

Normalized cointegrating coefficients (standard error in parentheses)

COP	INFL	REER	RGDP
1.000000	0.000000	0.000000	-38.79450
			(12.6760)
0.000000	1.000000	0.000000	6.300551
			(2.11342)
0.000000	0.000000	1.000000	-40.54442
			(11.0186)

Adjustment coefficients (standard error in parentheses)

D(COP)	-0.097415	0.000493	0.090244
	(0.05095)	(0.15979)	(0.05275)
D(INFL)	-0.073448	-0.898769	-0.075877
	(0.07124)	(0.22343)	(0.07376)
D(REER)	0.032664	-0.375032	-0.107051
	(0.11666)	(0.36587)	(0.12078)
D(RGDP)	-0.028944	0.139926	0.073348
	(0.02929)	(0.09185)	(0.03032)

Vector Auto-Regressive Estimates Result

	COP	INFL	REER	RGDP
COP(-1)	-0.169151	-0.137032	0.750372	-0.251194
	(0.41625)	(0.72766)	(1.43273)	(0.28786)
	(-0.40637)	(-0.18832)	(0.52373)	(-0.87261)
COP(-2)	1.255001	0.128365	-1.550155	0.223567
	(0.54534)	(0.95332)	(1.87705)	(0.37714)
	(2.30133)	(0.13465)	(-0.82585)	(0.59280)
INFL(-1)	0.306582	0.354238	-0.703655	0.033254
	(0.16130)	(0.28197)	(0.55520)	(0.11155)
	(1.90067)	(1.25627)	(-1.26739)	(0.29810)
INFL(-2)	0.001425	-0.298780	0.135127	0.082010
	(0.11277)	(0.19714)	(0.38816)	(0.07799)
	(0.01264)	(-1.51557)	(0.34812)	(1.05155)
REER(-1)	0.132697	-0.014581	0.404704	0.150791
	(0.08578)	(0.14996)	(0.29527)	(0.05933)
	(1.54688)	(-0.09724)	(1.37064)	(2.54177)
REER(-2)	0.024467	-0.183524	0.506986	-0.051924
	(0.07883)	(0.13780)	(0.27133)	(0.05451)
	(0.31039)	(-1.33181)	(1.86856)	(-0.95248)
RGDP(-1)	0.284547	1.023558	0.169161	-0.329637
	(0.39703)	(0.69405)	(1.36656)	(0.27457)
	(0.71670)	(1.47477)	(0.12379)	(-1.20056)
RGDP(-2)	0.483000	0.205628	0.076091	-0.244253
	(0.34151)	(0.59700)	(1.17547)	(0.23618)
	(1.41432)	(0.34444)	(0.06473)	(-1.03420)
C	-5.852419	20.80700	40.48925	-6.727801
	(7.61695)	(13.3153)	(26.2175)	(5.26762)
	(-0.76834)	(1.56264)	(1.54436)	(-1.27720)
R-squared	0.881760	0.572451	0.839662	0.581289
Adj. R-squared	0.793079	0.251790	0.719409	0.267256
Sum sq. Resids	1146.153	3502.550	13578.82	548.1628
S.E. equation	8.463721	14.79559	29.13204	5.853219
F-statistic	9.943122	1.785220	6.982448	1.851045
Log likelihood	-94.46384	-110.6615	-130.3093	-83.76872
Akaike AIC	7.411299	8.528379	9.883399	6.673705
Schwarz SC	8.024225	9.141305	10.49632	7.286631
Mean dependent	29.71172	19.77931	54.93858	2.937931
S.D. dependent	18.60627	17.10489	54.99638	6.837837
Determinant Residual Covariance		1.43E+11		
Log Likelihood		-619.3783		
Akaike Information Criteria		48.09506		
Schwarz Criteria		51.77261		

Source: **Author's Computations (2015).**