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INTERACTION BETWEEN OIL PRICE SHOCKS AND NIGERIA'S NON-OIL MACROECONOMY

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Abstract

Past Nigeria specific studies on oil price shocks-macroeconomy association had earlier discovered a significant real effective exchange rate appreciation, which is suggestive of the existence of "Dutch Disease" in Nigeria. As a result, this paper undertook a detailed investigation into oil price shocks-non-oil macroeconomy association, which it believes should be the first major step to solving the "Dutch Disease" problem in Nigeria. Analysis was conducted using linear and non-linear variants of oil price, employing the multivariate Vector Autoregressive (VAR) and Vector Error Correction (VEC) models respectively. Results indicate that both measures of oil price account for remarkable changes in real exchange rates, and the transmission effects of these variations on non-oil export and import are both negative. On the bases of this, the paper recommend policies geared towards evolving realistic and stable exchange rates for the naira, to complement current efforts being made to diversify the economy in the direction of non-oil productions.

Keywords: Oil Price, Shocks, Non-Oil Macroeconomy, Linear Measures, Non-Linear Measures

INTRODUCTION

The pioneering efforts of scholars four (4) decades ago at modeling the effect of variability in oil price on real economic activity, subsequently sparked–up more studies and debate among economists in different countries across the globe, as the search for plausible explanations for the relationship between oil price movement and macroeconomic performances rages on (Rasche and Tatom, 1977; Dagut, 1978; Dohner 1981; Darby, 1982; Lillien, 1982; Hamilton 1983 etc). This development may have been necessitated by the domineering influence which the oil sector has on the rest of the economy, especially with respect to the determination of levels of macroeconomic aggregates. As a result, knowledge of links between variability in oil price and levels of macroeconomic aggregates become of great importance for policy. The foregoing offers reasons why this has become a topical issue and has occupied the attention of economists over these decades such that a number of functional specifications have been explored, and investigations focused at one time or the other on chosen macroeconomic aggregates. From the debate, several authors suggested that the apparent weakening of the relationship between oil prices and economic activity is illusory, arguing instead that the true relationship between oil prices and real economic activity is rather asymmetric (Mordi and Adebiyi, 2010).

International empirical literature on this issue is drawn along three lines. The first group of studies had investigation into economic aggregates' responses to unanticipated and permanent shocks to oil price as their focus (Rasche and Taton, 1977, 1981; Bruno and Sachs, 1982, 1985). Hamilton (1983) then served as a spring board for a shift of emphasis in the direction of macroeconomic analysis of shocks from oil price to the supply side, employing the Granger causality text statistics in testing the direction of effect of such shocks within a business cycle framework; this posit symmetry in the response of macroeconomy to increases and decreases in oil price. Other studies drawn along this line include Hooker, 1996; Sadosky, 1999, Cunado and De Garcia, 2003; Elder and Serletis, 2008; Rahman and Serletis, 2008. Hooker (1996) for instance, studied the asymmetric effect of oil price shocks on GNP by analyzing the response of interest rate to oil price shocks. The paper believes that monetary policy responds to oil price increases and not to decreases. Failure of oil price collapse of 1986 to result in economic boom for most countries gave birth to another group of investigators. Notable among these is Mork (1989). Mork (1989) served as basis for growing skepticisms on the attribution of recessions, or their deepening in the past to positive shocks to oil price.

On the domestic front, past research efforts in Nigeria, were directed at investigations into plausible explanations of the macroeconomic effects of oil price shocks on economy-wide aggregates like real income, oil revenue, money supply, government expenditures, real and nominal exchange rates, real interest rates, inflation etc. (Olomola and Adejumo, 2006; Olusegun, 2008; Akpan, 2009; Aliyu, 2009a, 2009b; Adeniyi, 2011;Madueme and Nwosu, 2012; Udoh and Egwaikhide, 2012; Onyeyemi, 2013; Oriakhi and Iyoha, 2013. Secondly, Akpan (2009) and Mordi and Adebiyi (2010) carried out investigations into the asymmetric effects of oil price shocks. However, despite these avalanches of Nigerian specific studies, efforts has so far not been made to specifically focus investigations on non-oil macroeconomic aggregates, with a view to assessing the magnitude and direction of these effects on chosen key non-oil macroeconomic aggregates. This is where this study departs from existing Nigerian studies, as it investigates the relationship between oil price shocks and set of non-oil trade macroeconomic aggregates in Nigeria.

The paper is organized into four sections. Section 1 is the introduction; section 2 deals with data and methodology; section 3 focuses on estimation result; while section 4 concludes the investigation and proffering policy options.

METHODOLOGY

The data employed in the analysis span over period of thirty observations. Non-oil Export (NOX) and Non-oil Import (NOM) are sourced from the Central Bank of Nigeria's statistical bulletin (2010); the CBN publishes annual figures of these aggregates. Real exchange rate (REXG) is sourced from the African Heritage Institute Enugu, Nigeria. Processed data of this aggregate is available in the data bank of the institute. Data for oil price were sourced from the energy Department of U.S Energy Information Administration, Washington D.C.

Model Specification

The linear measure of oil price (specified in the model as LOPI) was subjected to a measure of statistical transformation. To do this, we follow Hamilton (1993) in specifying LOPI as the first Logarithmic differences of the oil price variable as:

$$\Delta o_t = \ln o_t - \ln o_{t-1} \qquad (1)$$

Where o_t is the oil price in period "t", and "In" represents the logarithmic notation.

Furthermore, to model the volatility adjusted measure of oil price shocks (SOPI), we adopt the Generalized Autoregressive Conditional Hetroscedasticity (GARCH(p,q)) model.

This is specified as:

Model 1:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \lambda_i \sigma^2_{t-i} + \sum_{j=1}^{q} \gamma_j \mu^2_{t-j} + \sum_{k=1}^{n} \beta_k \gamma_k \qquad (2)$$

Where σ_t^2 is variance at time 't", σ^2_{t-i} is variance at previous period, and μ^2_{t-j} is squared lagged residual term.

For the non-negativity condition of the forecast estimates of the conditional variance, the above variance equation is modified as to also solve the restriction problem of GARCH models, by following Nelson (1991) Generalized E-GARCH (p,q) model:

$$\ln(\sigma^2_t) = \alpha + \sum_{i=1}^{p} \lambda_i \, In\left(\sigma^2{}_{t-i}\right) + \sum_{k=1}^{n} \beta_k \gamma_k + \sum_{j=1}^{q} \left[\omega_j \left| \frac{\mu_{t-j}}{\sigma_{t-j}} \right| + \theta_j \frac{\mu_{t-j}}{\sigma_{t-j}} \right] \quad - \ (3)$$

Where $\alpha, \lambda_i, \beta_k, \omega_j \, \theta_j$ are parameters for estimation.

For the causal relationship between oil price shocks and the set of non-oil macroeconomic aggregates, we adopt the Vector Autoregressive (VAR) model. The model in its general form is specified as:

Model 2:

$$X_i = \alpha_i + \beta_i \sum_{j=1}^{k} x_{t-1} + \partial_i \sum_{j=1}^{k} y_{t-1} + \mu_t \quad - - - \quad - \quad - \quad - \quad - \ (4)$$

Where

X_t	=	4x1 vector of endogenous variables
Y_t	=	4x1 vector of explanatory variables
α_i	=	4x1 vector of constant terms
βi	=	4x4 coefficient matrix of the autoregressive terms
∂i	=	4x4 coefficient matrix of the explanatory variables
μ_t	=	vector of innovations
j	=	lag length
k	=	maximum lag length

The intuitive reasoning behind the necessity of GARCH (p,q) model is the fact that oil price increase will likely lead to a down-turn in economic aggregates, where volatility is low. On the other hand, an increase of similar scale will result in 3minimal effect under a highly volatile oil price regime (Cunado and Perez de Garcia, 2005; Zhang, 2008). Furthermore, VAR model is chosen for the causal relationship because, it is not vulnerable to simultaneity bias and offers means of explaining, predicting and forecasting values of set of economic aggregates. It also assumes endogeinity of all variables and there is no prior direction of causality amongst aggregates.

ANALYSIS & RESULTS

The study employed the method of two stage least square (2SLS) and maximum likelihood in estimation. This is necessitated by the chosen VAR model, where all variables are endogenous. But first, efforts were made to model the volatility of oil price aggregate (for the set of data in which volatility adjusted measure of oil price is considered as variant of oil price) to ensure the constancy of variance over time, using the GARCH (p,q) model.

An examination of the stationarity properties of each of the variables indicate that the linear measure of oil price shocks (LOPI) is integrated of order zero (I (0)). The volatility adjusted measure of oil price shocks (SOPI), non-oil import(NOM), non-oil export (NOX) and real exchange rates (REXG) are each integrated of order one (I (1)). Within the data set where LOPI is considered as the measure of oil price, the need for the conventional test of cointegration is obviated, since the variable (LOPI) and each of the set of non-oil macroeconomic aggregates have different order of integration. In contrast however, with SOPI as the measure of oil price, cointegration became an overriding requirement, given that the aggregate's order of integration coincides with that of each of the non-oil macroeconomic aggregates. The result of Johansen cointegration test revealed the presence of cointegration, as test statistics rejects the hypothesis of no cointegration, but indicates the presence of one cointegrating equation at 5 per cent level of significance. This suggests a long run relationship between SOPI and the set of non-oil macroeconomic aggregates. As a result, we estimate simple VAR model and VEC model respectively for the set of data with LOPI and SOPI as measures of oil price.

Table 1: Results of Augmented Dickey-Fuller Stationarity Test

Variable	ADF test statistics	Critical value	Stationarity State and Order of Integration
LOPI	-5.245490	1%	I(0) (Stationary)
SOPI	-7.237696	1%	I(1) (Stationary)
NOM	-4.945500	1%	I(1) (Stationary)
NOX	-7.062306	1%	I(1) (Stationary)
REXG	-4.524608	1%	I(1) (Stationary)

Descriptive Statistics

From descriptive statistics, normality test was carried out on each of the models examined, using the Jarque-Bera normality test. The Jarque-Bera statistics rejects the hypothesis of normal distribution, both for the linear and non-linear measures of oil price, given probability values each of which is above 0.05. This outcome is attributable to the sample size which may not necessarily be large. However, the residual correlation matrix for both measures of oil price showed the absence of serial correlation in each of the models estimated, as all their pair-wise matrices fall below the 0.8 rule of thumb mark. Again, both VAR stability condition and VEC stability condition checks indicate that the models are stable, given that no root lies outside the unit circle.

Impulse Response Functions

Here we examined and analyzed the response of each of the non-oil macroeconomic aggregates to a unit shock on the respective measures of oil prices. Results are drawn from our estimation of VAR model for the set of data where LOPI is considered as a measure of oil price, and VEC model for the set of data where SOPI is considered as a measure of oil price. The first columns of figures 1 and 2 (in the appendix) trace the response of each of the endogenous variables to unit shock on LOPI and SOPI respectively.

Impulse Response Function of shocks on LOPI: In figure 1, non-oil import (NOM) response to one time shock on LOPI is negative. From its initial response observed at period two, it exhibited a negative up and down swings which dies out after the seventh period. Non-oil export (NOX) also responds negatively to a unit shock on LOPI in a relatively weak up and down swings. The significance of this effect again dies out after the seventh period.

The response of real exchange rates (REXG) to a unit shock on LOPI is relatively minimal. Initially, the response of real exchange rates to this shock as observed in period two was positive, it decreased subsequently and became negative, but positive again as the variable increased in response to shocks on oil price after period four and half. This positive effect was subsequently maintained but the significance became muted after the seventh period.

Impulse Response Function of shocks on SOPI: The responses of the variables,(NOM and NOX) to shocks on SOPI is in no way different from what the responses are to LOPI. In fact, little difference observed in the impulse response of each of the aggregates to shocks on this measure of oil price, was with respect to real exchange rates (REXG). The aggregate (REXG), exhibited an increasing positive response to an initial shock on SOPI after the second period, as it remained increasingly stable, but decreased after the fifth period. It insignificantly increased to a long run stable level after the seventh period.

The general observation from the analysis above is the fact that, apart from REXG which responds to an initial shock on SOPI after the 3rd period, it took each of the aggregates two periods to respond to one time shock on oil price. Secondly, the seventh period is a significant period in the oil price shocks model, being that it marks the period in which the effect of oil price shocks becomes muted.

FIGURE 1: Impulse Response Function of LOPI

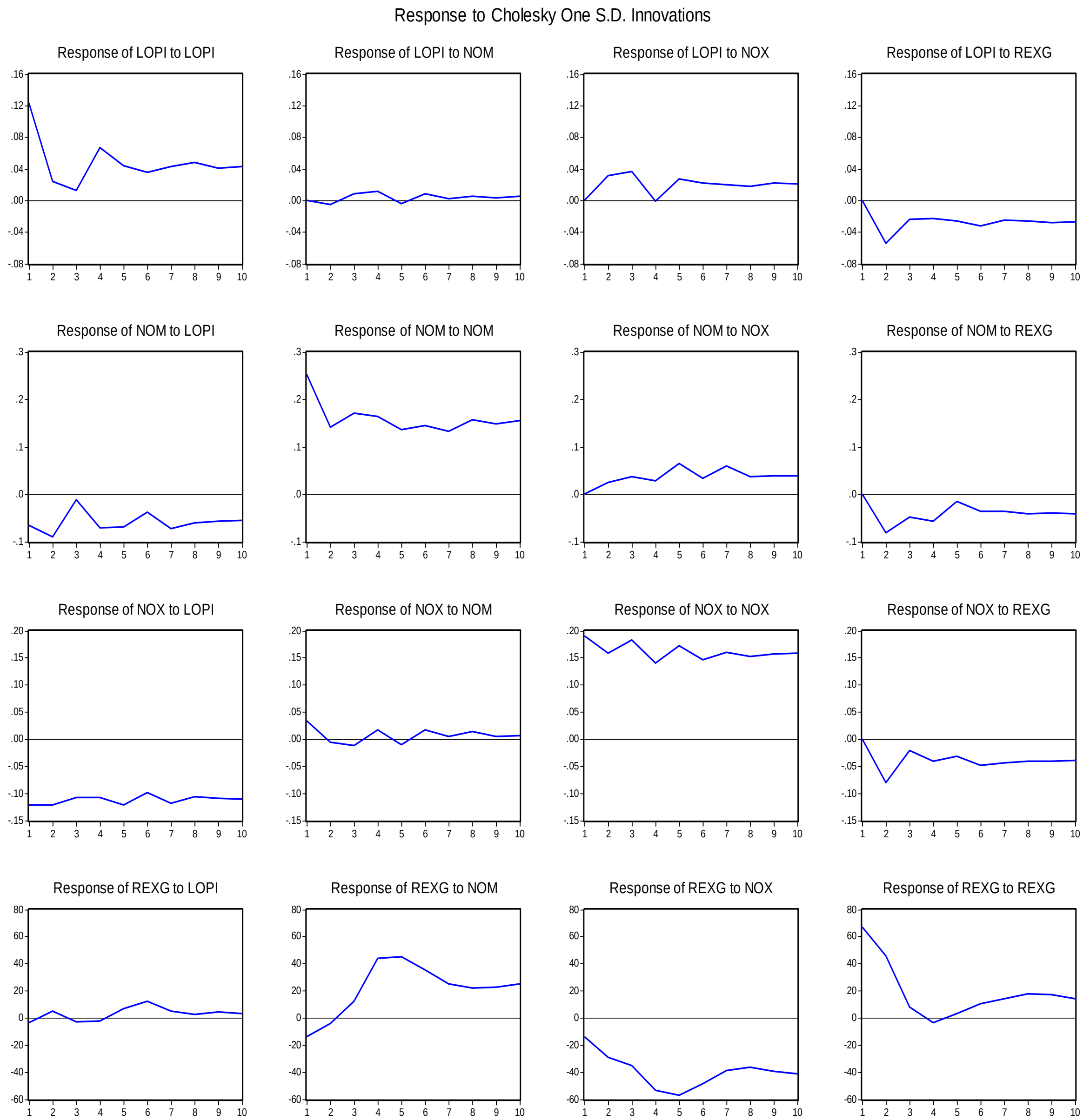
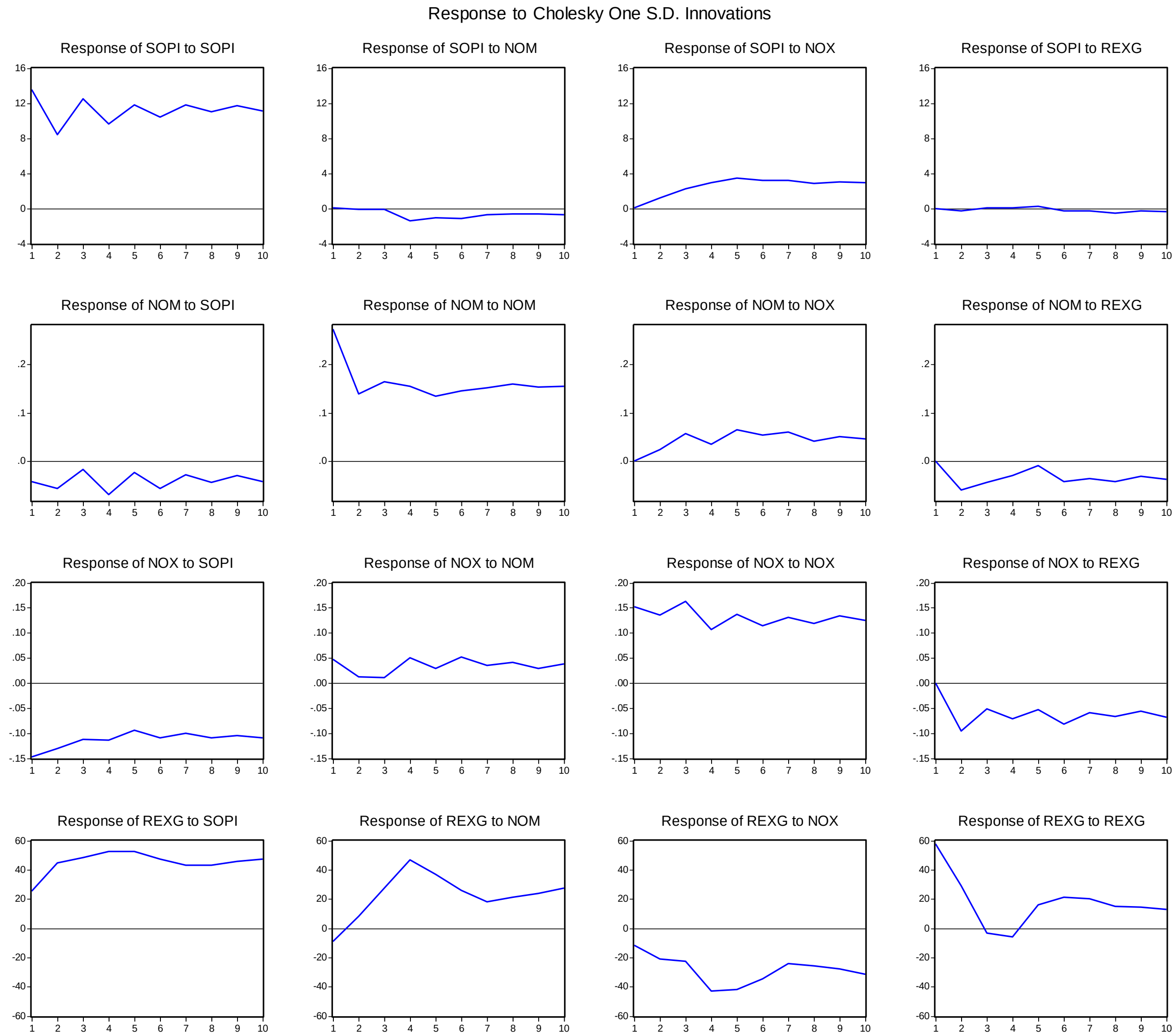


FIGURE 2: Impulse Response Function of SOPI



Variance Decomposition

Columns four of tables 2 and 3 specify the forecast error variance decompositions of each of the non-oil macroeconomic aggregates as a result of shocks on the respective variants of oil price (LOPI and SOPI). A summary of the result shows that on the average, LOPI accounts for 8.14 per cent of changes in REXG, 6.69 per cent of changes in NOM and 10.44 per cent of changes in NOX. On the other hand, SOPI as a variant of oil price measure accounts for 35.70 per cent of changes in REXG, 4.51 per cent of changes in NOM and 39.78 per cent of changes in NOX. Generally, observation shows that oil price shocks, (irrespective of the measure of oil price adopted) accounts for significant proportions of the forecast error variances of each of the non-oil macroeconomic aggregates examined. Analysis further reveals that oil price shocks exert more effects on REXG and NOX, more than it does on NOM.

Table 2: Variance Decomposition of LOPI

Dependent variable	Period	Standard error	LOPI	NOM	NOX	REXG
LOPI	1	0.100897	100.0000	0.000000	0.000000	0.000000
	5	0.117075	92.99465	1.567280	2.823526	2.614541
	10	0.117997	92.21892	1.900550	3.257612	2.603409
NOM	1	0.232661	4.021355	95.97864	0.000000	0.000000
	5	0.383171	8.717075	59.95510	21.86434	9.463484
	10	0.492736	7.339584	47.95380	38.38501	6.321613
NOX	1	0.220494	12.19994	13.11341	74.68665	0.000000
	5	0.375157	10.53585	17.45067	67.95385	4.059631
	10	0.461395	8.586983	24.39290	63.78948	3.230634
REXG	1	67.56499	4.236951	0.542105	0.019984	95.20096
	5	107.6204	10.30652	2.604095	31.55186	55.53752
	10	110.2830	9.861734	4.026279	32.01230	54.09969

Table 3: Variance Decomposition of SOPI

Dependent variable	Period	Standard error	SOPI	NOM	NOX	REXG
SOPI	1	13.49415	100.0000	0.000000	0.000000	0.000000
	5	25.89292	95.51041	0.508080	3.963884	0.017629
	10	36.69968	94.12504	0.511076	5.298294	0.065593
NOM	1	0.274059	2.339626	97.66037	0.000000	0.000000
	5	0.432422	5.527507	86.15862	4.961414	3.352459
	10	0.575526	5.653413	83.65677	6.693664	3.996149
NOX	1	0.216902	46.13419	4.653093	49.21271	0.000000
	5	0.444485	37.17835	2.949614	49.71436	10.15768
	10	0.602518	36.03004	3.756380	48.49620	11.71738
REXG	1	64.55877	15.20142	1.924115	3.384584	79.48988
	5	155,0443	43.51575	18.31355	19.67323	18.49748
	10	206.7107	48.39116	16.82474	20.95927	13.82483

DISCUSSION AND POLICY IMPLICATIONS OF RESULTS

Analysis reveals that each of the non-oil aggregates examined has significant association with international oil price movements. In other words, oil price changes significantly accounts for variations in levels of each of the non-oil macroeconomic aggregates. More specifically, real exchange rate is positively and directly affected by oil price movement. This in turn, is negatively transmitted promptly and widely to the determination of levels of non-oil import and export. Under a deregulated economy, positive shocks on oil price over a considerable period, translates to increases in the levels of Nigeria's external reserve. Increased external reserve raises the economy's capacity for imported manufactures and production inputs requirements for the development of the non-oil sector. Ordinarily, a development as this, would have called for celebrations, but this is not to be because, it leads to the appreciation of the naira rate of exchange, through the mechanism of demand and supply of foreign exchange. Exchange rates appreciation raises the domestic prices of import and increases cost of production in the non-oil sector, given Nigeria's heavy reliance on imported inputs for production. Increased cost of production translates to reduction in outputs, giving rise to increases in the unit prices. This renders these outputs in-competitive. A development as this, accounts for the closure of many industries in the non-oil sector-hence the observed "Dutch Disease Syndrome" (DDS) in Nigeria.

To trace the transmission of this observed positive impact of oil price changes on real exchange rates, to the determination of levels of non-oil import and export, we draw insight from the theoretical underpinnings. From the theory, exchange rates appreciation leads to increases in the domestic prices of import and subsequently to increase in the cost of production, arising from high cost of imported inputs. The development is expected to bring about a reduction in levels of import through the demand and supply mechanism. Export also reduces, partly as a result of output reductions and partly as a result of the outputs not able to command internationally competitive prices. Therefore, the fact that oil price shocks positively and directly affects real exchange rates, the transmission effect of which negatively affects levels of non-oil import and export, follows theoretical underpinnings. A critical examination of Nigeria non-oil exports over the period under investigation reveals that a very high proportion of the export is made up of worthless primary products. Manufactures- as a component of non-oil export is quite minimal. Efforts on the part of the government to remedy the ugly situation through diversification away from the oil sector, in the direction of non-oil productions, have so far yielded no meaningful result.

Failure of past efforts is not unconnected with Nigeria's inability to evolve a realistic and stable exchange rate of the naira. Development of any given sector requires long term planning and execution. For one to plan long term, successfully execute such plans and achieve set goals, requires realistic and stable exchange rates. It is however unfortunate that since the deregulation of exchange rates under the Structural Adjustment Programme (SAP) Nigeria is yet to evolve a realistic naira rate of exchange. The naira continues to depreciate in value against major international currencies and our exports prices continue to fall relative to import prices, which continue to be on the increase. The consequence of this is the fact that, imported input requirements for the domestic industries remained out of reach to our domestic industrialists. The situation is however not the same for consumer goods, as Nigeria has become a dumping ground for foreign manufactures, given their lower prices in the domestic economy. This undermines efforts on the use of tariffs to offer protection to domestic infant industries, as a way of aiding their growth and development.

SUMMARY AND RECOMMENDATIONS

The study undertook an empirical examination of the possible effects of oil price shocks on key non-oil macroeconomic aggregates of the Nigeria economy, employing linear and non-linear (volatility adjusted measure) measures of oil price. Specifically, findings from the impulse response function showed remarkable differences in the response of real exchange rates from one time shock on different measures of oil price, but the final transmission effects of each of these measures on non-oil import and export are the same- negative.

On the other hand, the result of the variance decomposition analysis revealed that, each of the measures of oil price account for significant proportion of the forecast error variances of each of the non-oil macroeconomic aggregates. The minimal effect of the volatility adjusted measure of oil price shocks on non-oil import is however not unconnected with Lee et al (1995) preposition that, oil price movements are likely to be more important in an environment characterized by historically stable prices, whereas the effect of oil shocks may be muted where prices are known to be volatile. Nigeria's economic environment over the period under investigation, has been known to be characterized by unstable prices, hence the result obtained with SOPI in the model.

A major specific discovery in the study is the fact that, both measures of oil price account for high proportion of forecast error variances of real exchange rates. This happens to be the channel through which other non-oil trade macroeconomic aggregates are affected. The development brings to limelight the weak contributions of other factors upon which real exchange rates depend on. Under this circumstance, Nigeria is left with a very narrow policy options, giving the exogeneity of international crude oil price. Therefore, authorities in Nigeria should concentrate on ways of managing the adverse effects of shocks on oil prices, on the economy's macroeconomic aggregates. Policies geared towards evolving realistic and stable exchange rates for the naira is needed now and in the future. Policies of this kind will complement current efforts being made to diversify the economy in the direction of non-oil productions.

Realization of a stimulated growth and development in the non-oil sector, through massive investment of excess liquidity arising from positive shocks on oil price, shall in the long run enhance domestic productions, and reduce pressures on the naira. By this means, the observed negative impacts of oil price shocks on each of the non-oil aggregates would have been mitigated. Onodugo et al (2013) has earlier recommended a carefully thought-out policy of Public Private Partnership (PPP) arrangement, as a way of stimulating growth and development in the key sub-sectors of the Nigeria non-oil sector.

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