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JEL: F31, C22
Keywords: Exchange rate, oil price, Nigerian economy

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The real exchange rate of an oil exporting economy: Empirical evidence from Nigeria

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Abstract: In this study the long-run relationship between real oil price, real effective exchange rate and productivity differentials is examined using annual data for Nigeria over the period 1980 to 2010. We aim to investigate whether oil price fluctuations and productivity differentials affect the real effective exchange rate. The empirical results suggest that whereas real oil price exercise a significant positive effect on the real exchange rate in the long run. Productivity differentials exercise a significant negative influence on the real exchange rate. The study noted that, the real exchange rate appreciation of 2000-2010 was driven by oil prices. The findings of this study have important implications for exchange rate policy and are relevant to many developing economies where oil exports constitute a significant share of their exports.

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1. Introduction

The literature on oil price macroeconomic dynamics is vast; a large part of this literature has looked at the influence of oil price on exchange rate movements which is the key issue considered in this paper. Evidence of oil price fluctuations having a significant impact on the exchange rate of oil producing nations has been reported for Nigeria (Ozsoz and Akinkunmi,2011), Canada (Issa et al, 2008), Kazakhstan(Kutan and Wyzan,2005), Russia (Spatafora and Stavrev, 2003; Oomes and Kalcheva, 2007), Algeria (Koranchelian, 2005), Venezuela (Zalduendo, 2006), Egypt (Mongardini, 1998) and OPEC countries (Korhonen and Juurikkala,2007). While insignificant results or negative relationship has been reported for Norway (Bjornland and Hungnes, 2008; Akram, 2000, 2004; Habib and Kalamova, 2007), Canada (Amano and van norden, 1995a; Gauthier and Tessier, 2002) and Saudi Arabia (Habib and Kalamova, 2007)

In this paper, we estimate the long run effects of real oil price on real exchange rate using the Johansen framework based on annual data from 1980 to 2010. Testing whether real oil price has an impact on real exchange rate in Nigeria. Following Habib and Kalamova (2007), we construct Nigeria's productivity differential against thirty major trading partners and include it as an explanatory variable of the real exchange rate model. Productivity differential is used to capture the Balassa Samuelson effect. The list of major trading partners include Australia, Austria, Benin Brazil, Cameroun, Canada, China, Cotedevoire, France, Germany, Ghana, India, Ireland, Italy, Japan, Netherlands, New Zealand, Niger, Peru Portugal Senegal, South Africa, Spain, Sweden, Switzerland , Thailand, Turkey, U.A.E, U.K and U.S constituting more than 86% of the trade between Nigeria and the rest of the world.

According to the Balassa-Samuelson hypothesis formulated by Balassa (1964) and Samuelson (1964), an improvement in the productivity of tradable's relative to non tradable's if larger in other countries could lead to the appreciation of the real exchange rate. The Balassa-Samuelson effect is thus the mechanism by which an appreciation of the real exchange rate occurs owing to changes in relative productivity (Coudert, 2004). Given that oil price is the main export good driving the terms of trade in oil exporting countries, we use the real oil price as a proxy of the terms of trade and examine the influence of oil price fluctuations and productivity differentials on the real exchange rate. In practice, the price of the main exported good is often used as an indicator of the terms of trade (Sossounov and Ushakov, 2009).

Nigeria is currently the second largest oil exporting country in the Organization of Petroleum Exporting Countries (OPEC) and is heavily reliant on its crude oil exports which accounts for 95% of its exports and foreign exchange earnings and about 80% of Government revenue in annual budgets (EIA, 2010). Oil has been the dominant factor in Nigeria's economy since its discovery in 1956 (Budina et al, 2006). Variations in world commodity prices tend to influence the currency values of resource exporting economies (Clements et al, 2007). Oil exporting nations may experience exchange rate appreciation when oil price rise, conversely exchange rate of oil exporting nations may depreciate when oil price falls (see Akram, 2004 and Cashin et al, 2004).

Oil price is becoming increasingly volatile, between 2000 and 2008 oil price increased more than 6 folds from $23 per barrel in January of 2000 to peak at an all time high at $146 per barrel in July 2008 before crashing to $42 per barrel by December of 2008. Prices then began the year 2009 at below $40 a barrel, averaging $61.73 per barrel for the year peaking at $78 in November 2010. In 2011, the price of crude oil started the year on a high note hitting a 2 year high selling at $95 a barrel. The price has continued to trend upward as a result of political crisis in the Middle East.

Figure 1: Trend in Oil Prices

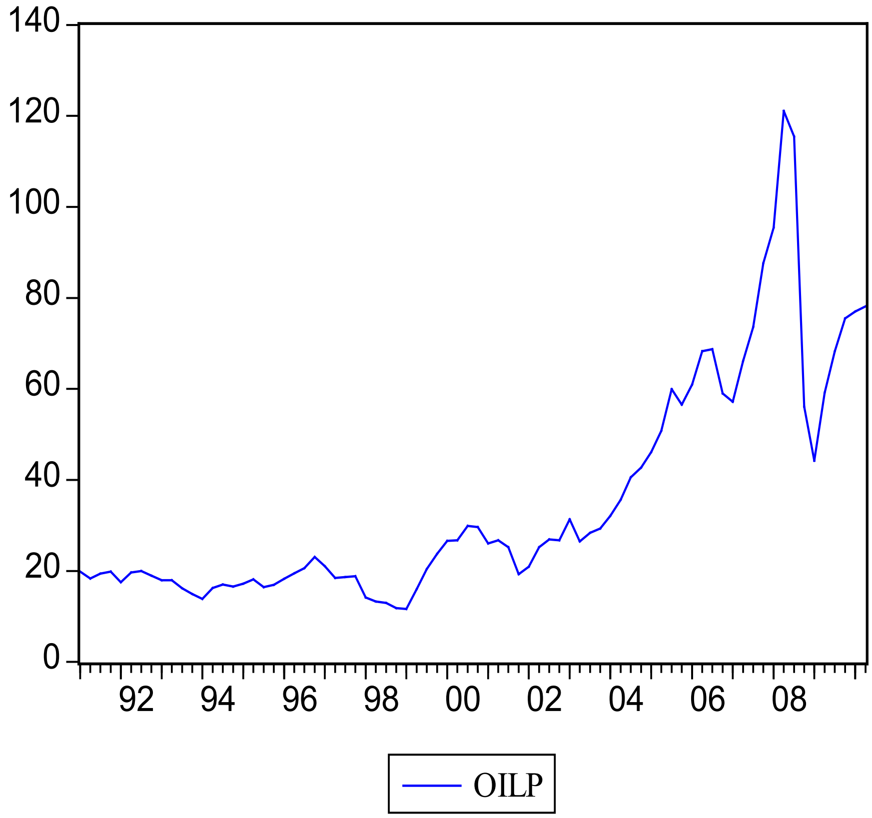
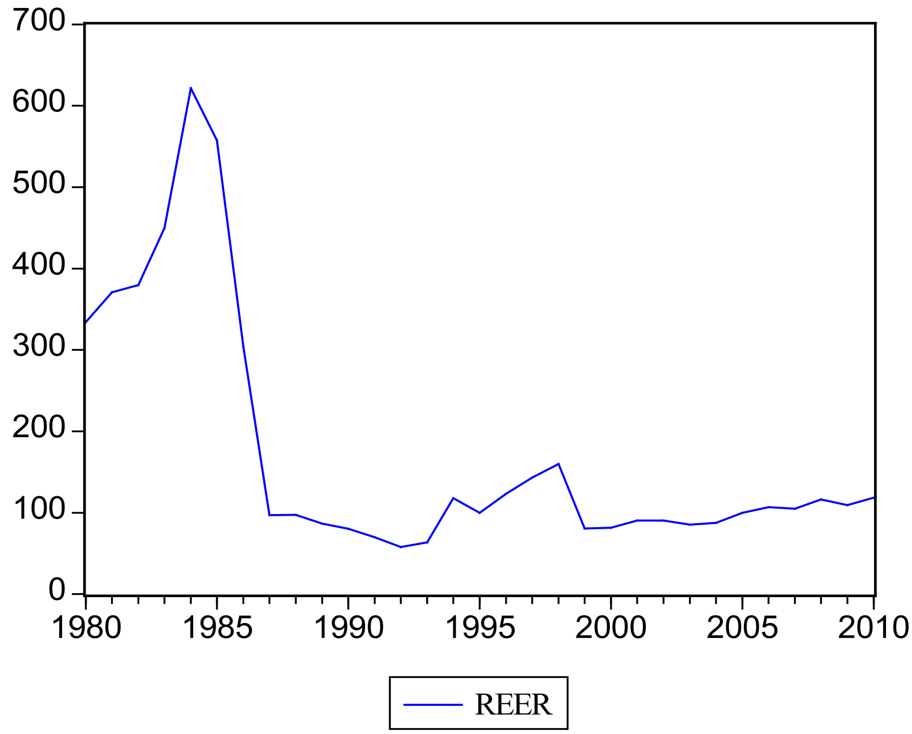


Figure 2 shows Nigeria's real effective exchange rate over the period 1980 to 2010. From 1980 to 1985 following the oil price increase, we can observe an upward trend with the real exchange rate appreciating significantly leading to loss of competitiveness for the Nigerian economy. In 1986, Nigeria experienced a sharp decline in its real exchange rate following declining oil prices and the Structural Adjustment Programme (SAP) which led to the devaluation of the Nigerian currency- the Naira. Between 1993 to 2000, there were substantial movements in the real exchange rate. Since then, the real exchange rate index fluctuated around a constant trend with evidence of mild appreciation of the real exchange rate. In recent years, owing to rising global oil prices and increased oil exports, Nigeria experienced large foreign exchange inflows. The real exchange appreciation could be described to be a response to the large foreign exchange inflow that characterised the Nigerian economy or it could as well be a response to productivity gains. The macroeconomic impacts of these fluctuations, the recent upward trend of oil prices and foreign exchange inflow pose challenges for exchange rate management in Nigeria.

Figure 2: Nigeria's real effective exchange rate



The purpose of this empirical paper is therefore to discern the long run relationship between oil price, productivity differentials and exchange rate in Nigeria. We aim to contribute to the literature on the Nigerian economy. From a methodological point of view, we construct Nigeria's productivity differential against thirty (30) major trading partners and include it as an explanatory variable in the real exchange rate model. While a lot of research has been ongoing in this area, the largest part of the literature has concentrated on developed economies. The study finds evidence that real oil price and productivity differentials adequately captures innovations in the real effective exchange rate but the Balassa-Samuelson effect is not of importance for real exchange rate dynamics in Nigeria. The rest of this paper is organized as follows. Following this introduction, section 2 presents the literature survey and theoretical framework while section 3 describes the data and the econometric methodology. In Section 4, we present the empirical results, while we summarize the major findings and draws conclusions in section 5.

2.1 Literature Survey and theoretical framework

According to Chaudhuri and Daniel (1998), in an oil producing country the relative price of the output bundle of commodities should rise when the relative price of oil increases creating an increase in the oil producer's real exchange rate. Consistent with many papers that have established the importance of oil price changes on relative prices, Cashin et al(2004) in a study of over 50 commodity exporting developing countries finds a long-run relationship between exchange rate and the exported commodity's price in one third of their sample. In a recent study, Ozsoz and Akinkunmi (2011) demonstrated the positive effects of world oil prices on Nigeria's exchange rate. Coleman et al (2011) using a pool of 13 African countries found no long run relationship between real effective exchange rate and real oil price for Nigeria. In a study on Asian economies, Tsen (2011) demonstrated evidence showing real oil price and productivity differentials among others were important determinants of the real exchange in the long run.

In a Panel of seven (7) OPEC countries including Nigeria, Nikbakht (2010) demonstrated the important influence of oil prices on the real exchange rate. The author showed that real oil prices have indeed been a dominant source of real exchange movement. Earlier on, Chen and Chen (2007) in a panel study for G7 countries similarly demonstrated that real oil have been the dominant source of real exchange movements. However while Aziz(2009) found evidence of a positive and statistically significant relationship between real oil price and real exchange rate for a panel of net importing countries, he found no evidence of long run relationship between real oil price and real exchange rates for a panel of net oil exporting countries.

Amano and van Norden(1996) noted the importance of real domestic oil prices for real exchange rate movements for Germany, Japan and the united states in the post bretton woods period. Chaudhuri and Daniel (1998) demonstrated that the non stationary behaviour of oil prices was responsible for the non stationary behaviour of US dollar real exchange rate over the post Bretton Woods era. Habib and Kalamova (2007) established a long run positive relationship between real oil price and real exchange rate for Russia and none for Russia and Saudi Arabia.

In a study of the Russian economy, Spatafora and Stavrev(2003) confirm the sensitivity of Russia's equilibrium real exchange rate to long run oil prices. Similarly, Suseeva(2010) demonstrated a long run positive relationship between the real oil price and the real bilateral exchange rate against Euro in Russia. Lizardo and Mollick(2010) provided evidence that from the 1970s to 2008, oil prices significantly explained movements in the value of the U.S dollar against major currencies. They found that when oil prices go up currencies of oil importers such as Japan suffer a depreciation. On the other hand, in net oil exporters such as Canada, Mexico and Russia, increase in oil prices leads to a significant depreciation of the US dollar. Akram(2004) finds strong evidence of no linear relationship between oil prices and the Norwegian exchange rates.

A number of papers have also previously suggested the potential role of productivity differentials in exchange rate determination. Amano and Van norden (1996) noted that earlier research on the role of relative productivity growth in explaining the behaviour of real exchange rate had been mixed. They observed that relative productivity were sufficiently small, gradual and therefore explained little of the overall movements in real exchange rates over the previous decades. Focusing on a small open economy, Pattichis and Kanaan (2004) provided considerable support for the Balassa Samuelson hypothesis for cyprus. They established a long run positive relationship exists between the relative price of non tradables and real income per capita. They found that both real income and real oil price significantly affects the relative price of nontradables consistent with the Balassa Samuelson hypothesis.

Choudhri and Khan(2004) using a panel of 16 developing countries provided strong evidence workings of the Balassa Samuelson effects. Coudert (2004) surveyed evidence that the trend appreciation in the real exchange rate observed in countries of central and Eastern Europe during the early 2000 stemmed in fact from a Balassa effect. The author noted that while other factors were equally responsible, the estimated Balassa effect goes some way in explaining the real appreciation. Kutan and

Wyzan (2005) using an extended version of the Balassa-Samuelson model including oil price finds evidence that changes in oil prices had a significant effect on the real exchange rate during 1996 to 2003 and that the Balassa- Samuelson working through productivity changes may be present though its economic significance may not be large.

The theoretical underpinnings of this study are based on theoretical framework of exchange rate determination developed by Cashin et al. (2004). In describing the theoretical link, the authors considered a small open economy producing two different types of goods, a nontradable good and an exportable good called "primary good". Labour is the only factor of production employed by firms in the export and non traded sector to produce these goods. They also assume production is undertaken by competitive firms which have access to constant returns to scale technology. Labour is also mobile across sectors and this ensures that wages are equated across sectors. The framework assumes only supply side factors were relevant and therefore abstracts from demand side considerations and concentrate on the long run relative price determination.

Both non traded and final tradable good which is imported and not produced locally are consumed by domestic consumers. While foreign firms in the process of producing the final tradable good employ the primary commodity along with an intermediate good not produced locally but produced only abroad. The final tradable good and a non traded good are consumed by foreign households. Cashin et al showed that the determination of the real exchange rate may be summarised by the following relation:

$$\frac{EP}{P*} = \left(\frac{a_X}{a1*} \frac{a_N^*}{a_N} \; \frac{P_X^*}{P_I^*} \right)^{\gamma} \qquad 1$$

Where P_X^*/P_I^* denotes the commodity terms of trade measured in foreign prices(i.e the price of the primary commodity in relation to the intermediate foreign good). while a_X/a_I^* accounts for the productivity differentials between the export and import(foreign)sectors and a_N^*/a_N corresponds to the productivity differentials between the local and foreign non traded sectors. The last two terms embody the Balassa

Samuelson effect. An increase in the productivity in the commodity sector tend to increase wages which leads to an increase in the price of the non traded good which finally leads to an appreciation of the real exchange rate.

3.1 Data and its Properties

The study uses annual data on real effective exchange rate based on relative CPI and average crude oil spot price obtained from IMF International Financial Statistics. The annual data ranges from 1980 to 2010 for a total of 31 observations. The study period is dictated by data availability. All variables were expressed in natural logarithms prior to econometric analysis for better fit and to reduce the problem of heteroscedasticity.

Drawing on related existing literature, we construct the annual real oil price as the nominal average price of crude in US Dollars deflated by the IMF index of the unit value of world manufactured exports. This is in line with (Cashin et al, 2004; Habib and Kalamova,2007 and Suseeva,2010). Following Habib and Kalamova (2007), we use a proxy to calculate the productivity differential variable defined as the trade weighted relative productivity differential against trading partners productivity, where Productivity is PPP GDP per capita. Data on GDP per capita based on PPP are from the World Bank world economic indicators. Symbolically:

$$PROD=\Pi_{j=1}(productivity_i/productivity_j)^{w_{ij,}} \quad 2$$

Where $productivity_i$ and $productivity_j$ denotes productivities of Nigeria and the trading partner. Average weighted productivity differential of 30 major countries who are Nigeria's partners in trade is calculated, for period t in the following way:

$$PROD=(GDPc_{it})^{Wit}(GDPc_{it})^{W2t} \cdots (GDPc_{it})^{w30t} \quad 3$$

The formula for calculating the weights is the following:

$$W_i = M_i + X_i \Big/ \sum_{i=1}^{n} X_i + \sum_{i=1}^{n} M_i$$

Where:

W_i = weight of country i in the overall trade volume of the country.

M= Import of Nigeria from country i;   X= Export of Nigeria to country i

$\sum_{i=1}^{n} X_i$ = Exports of Nigeria to 30 major trading partners;

$\sum_{i=1}^{n} M_i$ = Imports of Nigeria from its 30 major trading partners

Weights are calculated for Nigeria's thirty major trading partners based on the total volume of trade using country specific trade shares as weights. The data is obtained from the Direction of Trade statistics (DOTS).

A priori, we expect the coefficient of terms of trade (oil price) to have a positive effect on the REER. An improvement in the terms of trade will tend to increase the real exchange rate through income and wealth effects (AlShehabi and Shuang, 2008**)**. The coefficient of the productivity differential is expected to have a positive sign since productivity gains are believed to lead to higher real exchange rate.

Table 1 presents the descriptive summary statistics for the Real exchange rate, Productivity differential and real oil price. It is apparent from the standard deviation that REER has the highest volatility even higher than the real oil price. The distributional properties of our productivity differential variable appear to be non normal. The Jarque-Bera statistic and its associated p value reject the null hypothesis that the variable is normally distributed. All series have positive skewness and kurtosis indicate leptokurtic distribution.

Table 1: Summary Statistics

	LREER	LROILPMUV	LPROD
Maximum	6.432215	-0.463468	-0.964337
Minimum	4.059603	-2.268752	-1.490759
Std. Dev.	0.68024	0.510696	0.10791
Skewness	1.052754	0.335166	1.312051
Kurtosis	2.74319	1.901261	5.69312
Jarque-Bera	5.623897(0.06)	2.070717(0.35)	17.67351(0.00)

3.2 Methodology,

The Johansen systems procedure is used to test for the presence of a long-run relationship. The Johansen method for testing for cointegration is based on the properties of a Vector Error Correction Model (VECM) and takes the form:

$$\Delta \boldsymbol{z}_t = \Pi \boldsymbol{z}_{t-1} + \sum_{j=1}^{p} D_j \Delta \boldsymbol{z}_{t-j} + \boldsymbol{v}_t \qquad \textbf{5}$$

Where the vector of I(1) endogenous variables z_t=[LNREER$_t$, LNPROD$_t$, LNROILPMUV$_t$], ΔZ are all I(0) variables v_t is a (3 x 1) vector of white noise error terms. D is a (3x3) matrix of coefficients of deterministic terms. The π matrix contains information regarding the long run relationships, it is decomposed into n x r matrices of α and β such that $\Pi = \alpha\beta'$, with the /columns of matrices β representing the r linear combinations of X_t that are stationary or cointegrated and the columns of α is the vector of speed of adjustment to equilibrium coefficients(Asteriou and Hall, 2006). Johansen (1988, 1991) proposed two statistics, the trace and maximum eigen value statistic which take the form

$$\lambda_{trace}(r) = -T\sum In(1-\hat{\lambda}_i) \quad \text{and} \quad \lambda_{\max}(r, r+1) = -T\ In(1-\hat{\lambda}_{r+1}) \qquad 6$$

Where T is the number of observation, λ_i are the ordered eigenvalues and λ_r is the eigenvalue corresponding to r cointegration vectors(Wang, 2003). The λ_{trace} is a joint test with the null that the number of cointegration is less than or equal to r against the alternative that there are more than r. While λ_{max} has as its null hypothesis that the number of cointegrating vectors is r against the alternative of r+1 (Brooks, 2008). Since there are three variables there can be at most two linearly independent cointegrating vectors i.e. $r \leq 2$.

Our empirical analysis proceeds as follows: We first investigate the integrational properties of our variables and then search for any potential cointegrating relationship. Assuming the real effective exchange rate, productivity differential and oil price are stationary, we will then check if change in real oil price and productivity differential can explain the REER.

4. Empirical analysis

The empirical analysis examines whether oil price fluctuations and productivity differentials affect the real effective exchange rate using Johansen's VAR technique. Table 2 summarizes the results of the unit root tests based on the Augmented Dickey Fuller (ADF) and Philips Perron (PP) test. We include both (i) an intercept and (ii) an intercept and trend in the estimation. As noted by Habib and Kalamova (2007) and Taylor (2003), identifying the integrational properties of the real exchange rate is a difficult task due to their near unit root behaviour as both stationary and non stationary data generating processes may characterise the real exchange rate. Using both ADF and PP unit root tests, the common suggestion is that the real effective exchange rate (REER) and real oil price (ROILP) and Productivity differentials(PROD) are non stationary in their levels and stationary at their first difference. The result of the unit root test is unequivocal regarding the order of integration.

Table .2: ***Augmented Dickey Fuller Test and Phillip Perron and DFGLS***

Variables	***ADF***		***PP***	
	(i)	***(ii)***	***(i)***	***(ii)***
LREER	-1.66	-1.42	-1.78	-1.62
LROILP	-0.94	-0.92	-0.93	-1.36
LPROD	-1.91	-1.30	-3.79	-2.88

Proceeding with the cointegration analysis, Table 3 reports the results of the Johansen cointegration test. We first estimated a VAR in levels to determine the optimal lag length as cointegration is sensitive to lag length. Starting with two lags due to the limited number of observations, we limited the maximum lag to one in the lag length selection process based on LR, SC and HQ after having checked for the absence of residual serial correlation. The VAR also satisfy other stability condition and there was no root lying outside the unit circle. Table 3 displays results of the cointegration analysis. The results of the λ_{trace} and λ_{max} statistics strongly suggest there exist one significant cointegrating vector. The result rejects the null of no cointegration but cannot reject the hypothesis that there is at most one cointegrating equation. On the basis of the λ_{trace} and $\lambda_{max,}$ there is evidence of one cointegrating vector and is significant at 5% and 1% respectively. The real exchange rate, real oil prices and productivity differential are therefore linked together by a long run equilibrium relationship as real oil price and productivity differential adequately capture innovations in the real effective exchange rate.

<u>Table 3: Johansen Maximal Eigenvalues Test and Trace Test</u>

LNREER LNROILP LNPROD

Null Hypothesis	**Alternative**	**Test statistic**	**p-value**
Trace test			
r=0	$r \leq 1$	30.75	0.01
r=1	$r \leq 2$	2.64	0.88
r=2	$r \leq 3$	*0.11*	*0.75*
Max.eigenvalue test			
r=0	$r \leq 1$	*28.11*	*0.00*
r=1	$r \leq 2$	2.53	0.88
r=2	$r \leq 3$	*0.11*	*0.78*

Table 4: Cointegration vector (t-Statistics [ ])

Cointegrating Eq:	**CointEq1**
LREER(-1)	1.000000
LPROD(-1)	4.631069 [13.0967]
LROILPMUV(-1)	-0.948019 [-3.26350]

The Johansen cointegration technique indicates that the three variables are linked together by long run equilibrium relationship which is presented in table 4 above. The long run parameters of the estimated system are given by the matrix after normalising by the coefficient of the real effective exchange rate. In the long run oil price (LOILP) exercises a significant positive influence on the real exchange rate (LREER). This long run positive relationship is as expected, positive and relatively large; it could be explained by the fact that Nigeria is an oil exporting country. This has been confirmed in a number of similar studies (see e.g Olomola and Adejumo, 2006 etc). A 1% change in real oil price will lead to a 0.94% increase in the real effective exchange rate. On the other hand Productivity differential exerts a negative influence on real exchange rate. Thus in Nigeria, the Balassa–Samuelson effects do not seem to play an important role in driving the real exchange rate indicating that higher productivity in Nigeria's traded goods sector vis a vis its trading partners decreases the real exchange rate in the long run. A 1 % increase in productivity differential will lead to a 4.3% decrease in the real effective exchange rate in the long run.

Over all, the findings suggest some significant dependency between oil price, Productivity differential and the real effective exchange rate. Given the relatively short time series, results should be interpreted with caution.

5. Conclusion

The paper examined whether the real exchange rate is affected by movements in the real price of oil, controlling for the possible role of productivity differentials against 30 major trading partners. In recent years owing to high global oil prices and increased exports, oil rich Nigeria experienced large inflows of foreign exchange. We observed a modest appreciation of the CPI based REER since 2000(figure 2). The real appreciation could be attributed to the large inflows of foreign exchange in the form of oil revenue during that period, or a response to productivity gains.

Our results also indicate that the Nigerian currency- the Naira could be described as an "oil currency" as results indicate a long run positive and significant relationship between real exchange rate and real oil price. Real exchange rate commove with oil price and productivity differentials in the long run. Secondly, there is a lack of support for the Balassa-Samuelson effect as indicated by the negative and significant coefficient on the productivity differential. The observed real exchange rate appreciation is attributed to improvements in oil prices and not the Balassa Samuelson effect. Policy makers need therefore to focus attention on the implication of real exchange rate appreciation due to foreign exchange inflows arising from oil revenue which is an indication of "Dutch disease" both in medium and long term.

Krugman (1983) and Gulub(1983) have long noted the influence of oil revenue through wealth effects on the exchange rate(Coudert et al, 2008). The Nigerian economy is a "commodity economy", as oil exports have maintained the largest share of Nigeria's total exports for decades. Salehi-Isfahani (1989) had observed that real appreciation rather increase in oil revenues was responsible for the phenomenal rise in Nigerian imports in the 1970s. Nigeria's real exchange rate needs to be moderated as a result of oil price fluctuations. Some level of real appreciation is inevitable given high oil prices , Nigeria's exchange rate policy has contributed to nations 'boom and bust' cycles over the past 30 years (Budina, et al, 2006).

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APPENDIX A: DIAGNOSTIC STATISTICS

(1) VAR LAG ORGER SELECTION CRITERIA:

Lag length: 1 lag is indicated by LR, SC and HQ while 2 lags is indicated by FPE and AIC. Only lag 1 is mathematically stable

(2) ROOTS OF THE COMPANION MATRIX

Root	Modulus
0.790048 - 0.170935i	0.808328
0.790048 + 0.170935i	0.808328
0.797599	0.797599

(3) Residuals:

Normal distribution test

Equation	J-B Statistic	Kurtosis
LREER	3.41 [0.18]	4.25[0.16]
LPROD	0.49 [0.78]	2.43[0.53]
LROILP	3.22 [0.19]	3.17[0.85]
Vector	7.13[0.30]	
	Vector tests	Hetero
	AR(4)	
LM(χ^2(29))	4.32(0.88)	
χ^2(36)		45.15[0.14]

Appendix B. TRADE WEIGHTS

Country	Weights
Australia	0.001635957
Austria	0.006508562
Benin	0.000996454
Brazil	0.057292656
Cameroun	0.007303799
Canada	0.012129604
China	0.044023045
Cotedevoire	0.022506575
France	0.069066547
Germany	0.054328436
Ghana	0.015056847
India	0.064862014
Ireland	0.003072404
Italy	0.022237348
Japan	0.024457047
Netherlands	0.056172547
Newzealand	0.001199098
Niger	0.001917903
Peru	0.001986605
Portugal	0.017477515
Senegal	0.004627856
South Africa	0.019018508
Spain	0.056926693
Sweden	0.006284097
Switzerland	0.008125213
Thailand	0.006574189
Turkey	0.004438241
UAE	0.005916858
UK	0.050769501
US	0.335876634