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OIL Price Volatility and Trade Balance: Cointegration and Causality Analysis in Nigeria.

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Abstract
The paper empirically examines the co-integration and causality between oil price volatility and trade balance in Nigeria. The Granger causality test within the Vector Error-Correction Model (VECM) was conducted to examine the direction of causality. The secondary quarterly data covering the period of 1990Q1 and 2014Q4 were employed. The results show the existence of short-run unidirectional causality running from oil price volatility to trade balance, from real exchange rate to trade balance and from trade balance to inflation rate in Nigeria. At the same time, a long-run bidirectional causal relation is also found running from oil price volatility, real exchange rate and inflation rate to trade balance, and from trade balance, oil price volatility and real exchange rate to inflation rate. The findings show that overreliance on crude oil by Nigeria as the main export commodity will continue to subject the country's trade balance position to fluctuations in the price of crude oil at the world market. Moreover, floating exchange rate policy may also affect Nigeria's trade position adversely being an economy that imports factually everything she consumes.
Keywords: Oil price volatility, Trade balance, Cointegration, Causality, Nigeria.

1. Introduction

Oil as a tradable commodity, is most considered as a primary impetus for international trade, with oil price volatility accounting for major uncertainty in the future prices of nearly all goods and services. In turn, this encourages consumers to postpone their purchases of durable commodities and for firms to delay investment. Assume international trade to be a function of aggregate expenditure, the resultant weakening of current aggregate demand given the decline in domestic consumption and investment may reduce the volume of international trade. As a macroeconomic sector forming economic output, international trade transfers the effects of global oil price shocks to GDP, with most extant research suggesting that oil price shocks have a significant influence on international trade, Ali Sotoudeh et al (2016). In line with this, Kilian et al (2009) argue that the impact of oil price shocks on the external accounts of an economy works through two main channels; the trade channel and the financial channel. The trade channel works through changes in quantities and prices of tradable goods whereas the financial channel works through changes in external portfolio positions and asset prices. Based on the broad objective of this study, we focus on the trade channel and discuss the mechanisms by which oil prices are expected to drive trade balance. It is widely argued in the literature that oil prices greatly affect the trade balance.

According to Schubert (2009), the shock in oil price in oil-importing economy greatly affects the output, investment, and consumption pattern; thus, the balance of trade and the current account changes accordingly. The price of imported raw materials changes, with the increase in prices, the imported goods become costly and thus net export declines. Furthermore, oil prices leads to inflation, the more specific concern of stagflation, a situation in which the economy suffers inflation in conjunction with a decline in output. More specifically, the indirect impact of oil price shocks is the transmission through the international economy. A rise in world oil prices brings inflationary pressure and raise prices in trading-partner countries. This in turn raises domestic import prices, both for oil-importing and oil-exporting economies. Further, foreign monetary authorities may raise interest rates in an effort to control inflation, leading to declines in consumption, investment, and thus economic growth in foreign economies. Subsequently, this decreases the demand for many export commodities from the domestic economy and reduces trade balance (Le, 2011).

Previous studies have concentrated on the relationship between oil price volatility and macroeconomic variables for many developing countries around the world. Several empirical studies have also established the relationship between oil price volatility and exchange rate in particular. The goal of those studies is to establish the relationship between oil price volatility and macroeconomic performance as well as the effect of oil price volatility on exchange rate, their results differ either as a result of the methodology employed or scope of the study. Therefore, there are few studies that examine the relationship between oil price volatility and trade balance in developing economies, and to the best of our knowledge this work is the first to examine the feedback effects between these two variables in Nigeria in particular. The rest of the paper is organized as follows: Section 2 presents the literature review. Section 3 presents the modeling, methodology and data. Section 4 shows empirical results, while Section 5 concludes the study.

2. Literature Review

Hassan and Zaman (2012), examines the impact of rising oil prices on trade balance of Pakistan by using ARDL approach. The result shows that there is a significant negative relationship among oil price shock, exchange rate and trade balance in Pakistan. Also, they established unidirectional causality running from oil prices to trade balance which indicates that oil prices dictates trade balance position for the Pakistan. In some other related study, Mohammed (2010) studies the impact of oil price volatility on export earning in Pakistan during the period of 1975-2008 with VECM as a method of investigation found that oil price has a negative correlation to export earnings and Pakistan's current account.

All these findings affirm the earlier study by Malik (2008a) in his study on challenges of high oil prices for Pakistan within the period of 1975-2006 in which he reports that a negative long-run relationship exists between oil prices and output. In contrary, Kumar and Olayeni (2013) examine the lead-lag relationship between oil prices and trade balance for India using the monthly data covering period from January 1980 to December 2011. Their results of wavelet coherence analysis show that in the significant region of coherency and associate time scale in all situations, real oil price is leading over the India's trade balance indicating that an increase in the oil price will increase India's trade balance.

Aliyu and Muhammed (2015) examine the long-run pass through of the official exchange rates into trade balance in Nigeria using threshold cointegration and asymmetric error correction modeling. They establish non-linear cointegration between the variables of interest. Also,

Akinleye and Ekpo (2013) examine the macroeconomic implications of symmetric and asymmetric oil price and oil revenue shocks in Nigeria, using the vector autoregressive (VAR) estimation technique. The study finds that both positive and negative oil price shocks influence real government expenditure only in the long run rather than in the short run. Furthermore, Olomola and Adejumo (2006) investigate the impact of oil price shocks on aggregate economic activity in relation to variables such as output, inflation, the real exchange rate and money supply, in Nigeria using quarterly data from 1970 to 2003. The findings show that oil price shocks do not affect output and inflation in Nigeria significantly. But, oil price shocks were found to significantly influence the real exchange rate.

The controversy surrounding the findings of the previous studies on this topic especially in developed countries and lack of concentration on this issue of the previous studies on Nigeria as regards the relationship between the oil price volatility and trade balance show that the topic still requires more research effort to properly understand the nature of their relationship for better economic policy

3. Methodology

3.1 Conceptual Framework

Based on the work of Hassan and Zeman (2012) the impact of oil price shocks on the external accounts of an economy works through two main channels, namely: the trade channel and the financial channel. The trade channel works through changes in quantities and prices of tradable goods whereas the financial channel works through changes in external portfolio positions and asset prices. Based on the broad objective of this study, we focus on the trade channel and discuss the mechanisms by which oil prices are expected to drive trade balance.

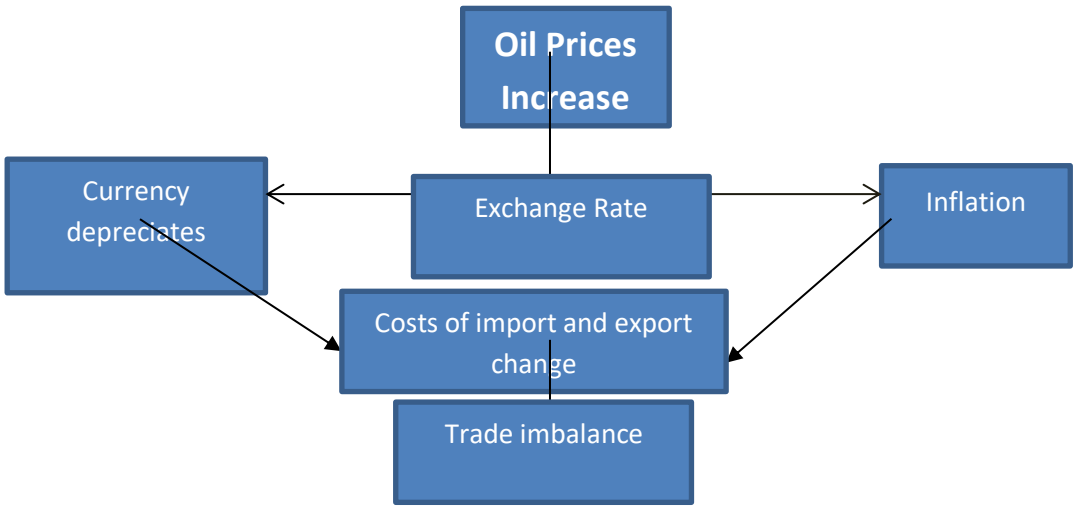

Figure 1 Conceptual Framework
Source: Adapted from Hassan and Zeman (2012) and modified by the author.

3.2 *Data*

This study uses secondary quarterly data on real exchange rate (REXR), trade balance (LTRD) measured by the difference between export–import, inflation rate (INF) and oil prices volatility

estimated from quarterly crude oil price using GARCH approach. This study covers the sample period of 1990Q1 to 2014Q4. The quarterly data on crude oil price selected is the spot price of crude oil by West Texas Intermediate (WTI), published by the US Energy Information Administration (EIA), and obtained from *http://tonto.eia.gov*. The data on Nigeria's trade balance data was sourced from the 2015 Central Bank's Statistical Bulletin and converted to quarterly data from its monthly form. Quarterly data on both exchange rate and inflation were directly obtained from the 2015 Central Bank's Statistical Bulletin.

3.3 *Model Specification*

To determine the causality among trade balance, oil price volatility, real exchange rate and inflation rate, a dynamic model of vector error correction model (VECM) representation of Engle and Granger (1987) is adopted. Then, we can investigate both long-run and short-run causal effect. Engle Granger causality test among the variables is developed as follows:

$$\begin{bmatrix} \Delta LTRD_t \\ \Delta OILVOL_t \\ \Delta REXR_t \\ \Delta INF_t \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} + \sum_{i=1}^{n} \begin{bmatrix} \alpha_{1i} & \gamma_{1i} & \lambda_{1i} & \theta_{1i} \\ \alpha_{2i} & \gamma_{2i} & \lambda_{2i} & \theta_{2i} \\ \alpha_{3i} & \gamma_{3i} & \lambda_{3i} & \theta_{3i} \\ \alpha_{4i} & \gamma_{4i} & \lambda_{4i} & \theta_{4i} \end{bmatrix} \begin{bmatrix} \Delta LTRD_{t-i} \\ \Delta OILVOL_{t-i} \\ \Delta REXR_{t-i} \\ \Delta REXR_{t-i} \end{bmatrix} + \begin{bmatrix} \partial_1 \\ \partial_2 \\ \partial_3 \\ \partial_4 \end{bmatrix} ECT_{t-i} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \end{bmatrix} \quad (1)$$

Where Δ denotes first difference, all variables are in their log forms. α_i ,γ_i , λ_i and $\emptyset_i$ are the short-run dynamic coefficients of the model's convergence to equilibrium. ECM_{t-i}, ECM_{2t-i} , ECM_{3t-i} and ECM_{4t-i} are the lagged error correction terms (that is, speed of adjustment) generated from the long-run association. Error correction term was incorporated in these four equations since there exist co-integration relationships when trade balance, oil price volatility, real exchange rate, inflation rate are treated as dependent variables.

Hence the long-run causality is determined by the significance of coefficient of lagged error correction terms using t-test statistic. Significant first differences of the variables provide evidence on the direction of short-run causality. The F statistic for the first differenced lagged independent variables is used to test direction of short-run causality between the variables.

4. Empirical Results

Unit Root Tests

Table 1 reports the result of the unit root test. The results shows that all variables except oil price volatility have unit root in their level as the p-values for all series except oil price volatility are not significant. Based on this estimated results, we accepted the null hypothesis of unit roots at all levels. However, when we performed the unit root test at first difference, the results showed that all the variables are stationary at first difference since the ADF statistics values exceeded the test Critical values in absolute terms at all levels.

Table. 1 Result of the Unit Root Tests

Augment Dickey Fuller				Phillips-Perron		
Variables	Level	1st Difference	Remarks	Level	1st Difference	Remarks
LTRD	-2.062	-10.291*	I(1)	-2.246	-10.332 *	I(1)
INF	-2.433	-7.332*	I(1)	-2.069	-7.390*	I(1
REXR	-0.8760	-8.791*	I(1)	-0.896	-8.793*	I(1)
OILVOL	-4.274 *	-	I(0)	-4.298 *	-	I(0)

Note: *, ** and *** denote 1%, 5% and 10% levels of significance respectively

Co-integration Test

After we have established that our time- series data are made up of variables that are majorly I(1), the next task is to test for the existence of co-integration, or otherwise, among the variables. In order to capture the extent of co-integration among the variables, the multivariate co-integration technique proposed by Johansen and Julius (1990) is adopted. Table 3 presents the results of cointegration test. The existence of co-integration confirms that there is long-run equilibrium relationship among trade balance, oil price volatility, real exchange rate and inflation in Nigeria between 1990 and 2014.

Table. Johansen Co-integration Test Results for All Variables.

Unrestricted Cointegration Rank Test (Trace)			**Unrestricted Cointegration Rank Test (Maximum Eigen Value)**	
No of CE (s)	**Trace Statistic**	**Probability**	**Max- Eigen Statistic**	**Probability**
None *	58.16100	0.0040*	28.33659	0.0400*
At most 1 *	29.82441	0.0496	21.13162	0.2300
At most 2	13.91147	0.0854	14.26460	0.2383
At most 3 *	4.293571	0.0382*	3.841466	0.0382*

*Note: *, ** and *** denote 1%, 5%, and 10% levels of significance respectively.*

Trace test indicates 3 co-integrating equations at the 0.05 level while Max-eigenvalue test indicates 2 co-integrating equation at the 0.05 level

Causality Test

Since evidence of cointegration among the variables has been established, there must be at least unidirectional or bidirectional causality among the variables. We therefore proceed to the

investigation of this relationship within the concept of Vector Error Correction Model (VECM) framework of equation (1). Table 4 presents results on the direction of short run and long run causality relationships among the variables. In the short run, the feedback effect shows the presence of unidirectional causality running from oil price volatility (OILVOL) to trade balance (LTRD), real exchange rate (REXR) to trade balance (LTRD) and trade balance (LTRD) to inflation rate (INF). Also, there is presence of bidirectional causality among the variables in the long run. Thus, REXR Granger causes LTRD at 5% level of significance, OILVOL Granger causes LTRD at 5% level of significance and LTRD Granger causes INF at 5% level of significance.

Table. VECM Granger Causality Test

	Independent Variables				**Long run Causality ECT Coefficients**		
Dependent	**Short run Causality [p-value]**						
Variable	**ΔLTRD**	**ΔOILVOL**	**ΔREXR**	**ΔINF**	**ECT_{t-1}**	**ECT_{t-2}**	**ECT_{t-3}**
ΔLTRD	--	25.23*** [0.003]	21.51** [0.043]	14.72 [0.257]	-0.0181** (-3.931)	-0.0114 (-3.697)**	0.0008 (1.641)
ΔOILVOL	17.93 [0.118]	-	2.392 [0.243]	1.935 [0.321]	0.0035 (0.015)	-0.0877 (-1.710)	0.0037 (1.063)
ΔREXR	15.82 [0.199]	12.32 [0.420]	-	13.98 [0.302]	1.2284 (0.857)	-0.465554 (-1.435)	0.0003 (0.016)
ΔINF	23.98** [0.020]	16.41 [0.173]	10.79 [0.546]	-	-3.6440** (-3.655)	0.2100 (0.931)	0.0503 (3.261)

Note: * Statistical significance at 5% level; ** Statistical significance at 10% level;

5. Conclusions

Based on the objective of this study, we conclude that there is only evidence of unidirectional Granger causality running from oil price volatility to trade balance in Nigeria within the short run. Therefore, government should design an effective and implementable macroeconomic policy that will help diversify the economy with a view to protecting the economy from adverse effects of oil price volatility. Also, government should come up with exchange rate management policy that will ensure Nigeria attains a favourable balance position, and macroeconomic policy that curbs imported inflation into the Nigerian economy should be put in place by the government.

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