EXCHANGE RATE VOLATILITY AND DYNAMICS OF NON-OIL TRADE: Evidence From Nigeria

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ABSTRACT

Motivated by the high prevalence of possible endogeneity bias among Nigerian specific studies, this study examined the effects of exchange rate volatility shocks on non-oil trade using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) (p, q) and the Vector Autoregressive (VAR) methods of analysis. Theoretically, the model for the study was founded on the relationship between trade and the size of price and foreign exchange elasticities of Nigeria and her trading partners. The result shows that non-oil import exhibited unending positive and negative swings in response to positive shocks on exchange rate volatility, as against a minimal negative effect on export which became muted after the third and half period. This suggests that exchange rate volatility is more relevant for the determination of non-oil import than export. On the basis of this, the study concluded that exclusive reliance on exchange rate adjustment as a policy management tool for non-oil trade can be counter-productive for Nigeria. As a result, the study recommended the establishment of industrial clusters to drive domestic production of internationally competitive non-oil products.

JEL classification: E32, E47, F14, F17

1. Introduction

The deregulation of the exchange rate arrangement in world trade dates back to the breakdown of the Bretton Woods System in the 1970s. Initially, as developed economies moved from a fixed to a more flexible exchange rate policy after the break, developing countries remained on a different peg arrangement. Devaluation and depreciation/appreciation constitute notable features of a deregulated exchange rate system. The former is a deliberate attempt by government to lower the value of domestic currency under a fixed or near fixed exchange rate regime for the purpose of gaining international competitive advantage. The later, on the other hand, defines a fall/rise in the value of domestic currency, orchestrated by forces of demand and supply. These allow for flexible adjustment of exchange rates. Recently, many developing countries have opted for more flexible exchange rate policy regimes, and/or have had to devalue their currency at different points in time, within the framework of various forms of managed floating exchange rate regimes. This has made exchange rate in these countries highly volatile, especially as their individual economies lack the productive capacity to sustain a stable exchange rate. The ease with which shocks to exchange rate are transmitted promptly and widely to the rest of the economy through trade, should be of great concern to national governments. Therefore, this study examined the effects of exchange rate volatility shocks on non-oil trade macroeconomic aggregates in Nigeria.

In the literature, various arguments have been raised on the likely effect of exchange rate volatility on economic performance such that views are polarized. A strand of the argument notes that, as a bi-directional short-term fluctuation in the rate of exchange, volatility in exchange rate exerts undesirable effect on macroeconomic aggregates; it induces a high degree of uncertainty in international transactions and thus discourages trade (IMF, 1984; Auboin and Ruta, 2011). Under this circumstance, risk-averse international trade agents tend to reduce their volume of transactions by re-allocating resources to domestic markets. Those with the opposing view argue that associated risk from uncertainty could be hedged through the forward exchange market such that it does not affect trade flows. Furthermore, empirical findings have so far not been able to resolve these issues as findings are mixed (Akinlo and Adejumo, 2014). This calls for further country-specific investigations to unravel the likely effects of exchange rate volatility on relevant macroeconomic variables.

In Nigeria, after years of external trade regulation and payment arrangements, a deregulated policy option was adopted to allow for a market determined exchange rate. This policy option was taken against the backdrop of the crash in international oil prices; hence, the need to diversify the external sector in the direction of non-oil trade. As a policy shift, exchange rate deregulation was aimed at finding a realistic exchange rate for the naira that could lower the prices of non-oil exports and enhance its international competitiveness relative to imports. Since inception of the policy in 1986, Nigeria has had about seven different regimes of exchange rate arrangement as the monetary authority (Central Bank of Nigeria, CBN) has tried to find a realistic and stable exchange rate for the naira; an exchange rate that would match demand for exports with imports. The Dutch Auction System (DAS) was operating in 1987, the Interbank Foreign Exchange Market (IFEM) in 1989 and the Autonomous Foreign Exchange Market (AFEM) in 1995. Between February 2000 and October 2013, the Wholesale Dutch Auction System (WDAS) was in operation. This gave way to the Retail Dutch Auction System (RDAS) in 2013. IFEM was reintroduced in February 2015, but abolished in June 2016 to make way for a liberalized foreign exchange market. In the liberalized foreign exchange market, the CBN intervenes directly or through the dynamic secondary market (CBN, 2016).

The switches in exchange rate policy regimes, which also were characterized by two devaluation episodes (1998 and 2015), instilled varying degrees of fluctuation in the naira rate exchange. The exchange rate for the naira vis-à-vis the US dollar moved from 1.8 in 1986, to 361.29 in 2018. In response, non-oil exports increased from ₦0.55billion in 1986 to ₦1434.17billion in 2018, and non-oil imports increased from ₦5.07billion in 1986 to ₦9758.93billion in 2018. Table 1 shows the time trend of naira-dollar rates of exchange and non-oil trade responses over the period 1986 to 2018.

Table 1. Time Trend in Naira – Dollar Rates of Exchange and Non-oil Trade Responses

Year	Naira-Dollar Exchange Rate	Non-Oil Export (₦billion)	Non-Oil Import (₦billion)
1986	1.80	0.55	5.07
1995	21.90	23.10	599.30
2005	131.30	105.96	2003.56
2012	157.50	879.34	6702.30
2015	192.40	660.68	9350.84
2017	333.72	1074.90	8189.39
2018	361.29	1434.17	9758.93

Source: Exchange Rates UK, 2019; CBN, 2019.

The table shows that there was a 199.72% increase in the exchange rate of the naira to the US dollar between the period 1986 to 2018. In response, non-oil exports and imports increased by 2606.58% and 1923.84% respectively. Given these statistical observations, it is essential to scientifically and empirically determine the responses of exports and imports to short and medium-term fluctuations in exchange rate.

Investigative efforts among a good number of Nigerian specific studies were on specific exports (Obiora and Igue, 2006; Owuru and Farayibi, 2016; Oyorwi and Ukarwe, 2013; Olufayo and Fagite, 2014). Another group of studies exclusively focused on non-oil exports (Aliyu, 2008; 2009a; Akinlo and Adejumo, 2014). Others examined the impact of exchange rate volatility on manufacturing outputs (Opaluwa, Ameh and Ume, 2010); as a matter of fact, Nigeria is a dual sector economy (oil and non-oil sectors). Mainly, each of these studies was limited by not considering possible endogeneity problems in the relationship between exchange rate and trade flows. Because the possibility of the problem of endogeneity was ignored, none of the studies deemed it necessary to employ the appropriate econometric model that could take care of this flaw. In this particular investigation, efforts were made to address this issue by means of the Vector Autoregressive (VAR) model of analysis. Secondly, in addition to the use of an appropriate model (that considers all variables as endogenous), the study made further addition to empirical knowledge by employing the GARCH (p,q) model. The GARCH model has the ability to make adjustments in a volatile aggregate, necessary for outcome reliability, such as in this case with exchange rate.

This paper has six sections; following this introductory section is section 2 which explores existing literature. Section 3 examines the data and theoretical basis for the study, while 4 specifies the empirical strategies adopted in the analysis, followed by the presentation of results and discussions in section 5. Section 6 presents the policy implications of the findings, as well as the conclusion and recommendation.

2. Literature Review

Empirical evidence on the effect of exchange rate volatility on trade is mixed because of the divergent views held on the theory. History of investigations that resulted in mixed findings across studies date back to Ethier (1973). Ethier's model focussed investigation on examining the risk-averse decision-making process of firms and how that affects inputs and forward exchange cover, given the uncertainties associated with exchange rate. In the face of underlying assumptions of risk-aversion, trade is found to deductively exhibit diminishing significant negative responses to volatility in exchange rate. In a more recent study of the Vietnam economy, Thuy and Thuy (2019) applied the bound testing approach to examine the impact of exchange rate volatility on exports over the period $Q_1$2000 to $Q_4$2014. Results show that exchange rate volatility exerts a negative long-run effect on the volume of exports. Yakub, Sani, Obiezue, and Aliyu (2019) also discovered similar findings. The study also adopted the GARCH-ARDL bound testing approach to co-integration, to analyse monthly data over the period 1997-2016. Evidence from their study showed that exchange rate fluctuations exert significant negative short-run effect on trade flows, and no long-run effect. Sugiharti, Esquivias and Setyorani (2020) equally provided further support for this outcome. The study carried out an investigation of the impact of exchange rate volatility on Indonesia's primary commodity exports to top five export destinations markets – United States, Japan, China, India, and South Korea. A monthly high frequency data spanning the period 2006-2008 was utilized, while the GARCH linear ARDL (LARDL), and non-linear ARDL (NARDL) models were employed in the analysis. The results of the LARDL and NARDL models indicate the negative effects of exchange rate volatility on exports. Other studies with similar findings include Akhtar and Hilton (1984), Hook and Boon (2000), Arize, Osang and Slottje (2005), Doganlar (2002), Tenreyo (2003), Broda and Romalis (2003), Baak (2004), Chit (2008), Anthony (2008), Ozturk and Kalyoncu (2009), Aliyu (2009), Oyorwi and Ukarwe (2013), Olufayo and Fagite (2014).

Contrary to the evidence above, some other studies discovered a positive association. Notable among these studies that provided positive effects of exchange rate volatility on trade flows is Akinlo and Adejumo (2014). Akinlo and Adejumo examined the effects of exchange rate volatility on non-oil exports in Nigeria over the period $Q_1$1986 - $Q_4$2008. The results of the error correction estimation show that volatility in exchange rate has a significant positive effect on non-oil exports. In a different investigation undertaken on the same period, Serenis and Tsonis (2014) examined the effect in the context of Croatia and Cyprus using broader measures of exports (overall aggregate exports) over the period $Q_1$1990 – $Q_1$2012. The findings provided support for positive association of exchange rate volatility on trade flows in both countries. Another study which provided positive association is by Osei-Assibey (2017). Osei-Assibey examined exchange rate volatility, uncertainty in earnings and bi-directional trade flows in Ghana. The results provided evidence of positive effects of exchange rate volatility on exports; observed negative effects on imports was however ineffective. Besides these, a reasonable number of other previous studies also had similar findings (Brada and Mendez, 1988; Klein, 1990; McKenzie and Brook, 1997; Doyle, 2001; Kasman and Kasman, 2005).

On the other hand, studies like Yuksel, Kusey, and Sevinc (2012) failed to provide any evidence that exchange rate volatility exerts significant effect on trade flows. By utilizing data spanning the period 2003:2 –2012:12, Yuksel et al., examined the impact of exchange rate volatility on exports in Turkey using multiple regression analysis. Evidence from the study shows insignificant negative effects. Denaux and Falks (2013) also had a similar finding for Turkey. The study examined this effect in the context of trades between Turkey and her top 5 trading partners in the EU. Data for the study covered the period $Q_1$1988 – Q_3 2011. Findings failed to provide any support of a significant effect of exchange rate volatility on import demand. This same outcome was also earlier observed in studies by Hooper and Kohlhagen (1978), McKenzie (1998, 1999), Aristotelous (2001), Boug and Fagereng (2007).

Furthermore, in addition to providing country-specific evidence on the subject matter, Akpokodje and Omojemite (2009) went a step further to provide support for the importance of country-specific investigations of the effect of exchange rate volatility on trade flows. The study examined this effect in the context of the Economic Community of West African States (ECOWAS) sub-region. The results of the GARCH-pooled model provided evidence of a significant negative effect of exchange rate fluctuations on import. On the other hand, the disaggregated model produced mixed outcomes, which was positive for the CFA sub-group and negative for the non-CFA sub-group.

A notable observation from empirical evidence is that a good number of the studies reviewed are limited by the fact that each carried out estimations within the framework of a single unidirectional equation model. Possible bias associated with the relationship between exchange rate and trade variables cannot be addressed within such specification; as a result, many of these studies are plagued by the problem of endogeneity.

3. Data and Theoretical Basis of Analysis

3.1 Theoretical basis of analysis

The framework for the analysis of the effect of exchange rate volatility on non-oil trade is a combination of Senhadji and Montenegro's (1998) model and the simple import demand model (Chan, 1974). Senhadji and Montenegro argue that the size of price and income elasticity of developing countries constitute key variables that explain demand for their exports.

On the other hand, the simple import demand model makes a case for the inclusion of the foreign exchange component in the import demand function. This accounts for the ability and capacity of the importing economy to import needed goods and services. Furthermore, export and import demand elasticities have been identified as critical parameters in assessing the effect of real exchange rate volatility on trade (Senhadji and Montenegro, 1998). For instance, the international market for exports exhibits more competitive behaviour at higher price elasticity. Under this scenario, devaluation policy for the exporting country shall be more successful in promoting export revenue. Studies that have employed similar functional specification include Nurusimhan and Pritechtt (1993) and Ichoku, Ntegah and Ikpe (2013) (for import demand function), and Okoh (2004), Aliyu (2007) (forexport demand function). The chosen eclectic model specifies the export/import demand model as a function of relative prices, world import capacity/domestic economy's import capacity and exchange rate volatility. Isolated income is excluded in the model because its influence is captured in the import capacity variable.

3.2 Data

High frequency data for relevant macroeconomic variables for the study were not readily available, hence the reliance on annual data. Non-oil export and non-oil import were sourced from various issues of the *Central Bank of Nigeria Statistical Bulletin*. The level of foreign reserves, merchandise import for US economy, real exchange rate and relative prices were sourced from the World Development Indicators. Domestic import capacity (DMC) was computed using Nigeria's level of foreign reserves and non-oil imports. On the other hand, import capacity for the US economy was utilized as proxy for world import capacity (WMC). For this purpose, world import capacity was computed from US level of foreign reserve, and merchandise import. Thus,

$$DMC = \frac{Nigeria's\ Level\ of\ Foreign\ Reserve}{Non-oil\ Import}$$ and

$$WMC = \frac{US\ Level\ of\ Foreign\ Reserve}{Merchandise\ Import}$$.

All variables except exchange rate volatility are in logarithmic values.

Among the known measures of exchange rate volatility, three are most commonly employed in empirical research. Adeoye and Atanda (2011) identified these measures as: (1) standard deviation (SD), which measures the standard deviation of the growth rates of exchange rate; (2) coefficient of variation (CV), which defines time-varying twelve month coefficient of variation in bilateral exchange rate; (3) first order difference (FD), which considers the difference between current logarithmic value of exchange rate and previous value. This study follows (Adeoye and Atanda, 2011) in the adoption of FD as a measure of exchange rate volatility. It is specified as:

$$FD_t = (lnEX_t - lnEX_{t-1}) - lnE\overline{X} \quad (1)$$

where:

EX = a measure of the bilateral exchange rate

$E\overline{X}$ = mean of bilateral exchange rate

ln = natural log

4. Estimation Strategies

4.1 Model specification

Drawing from the above theoretical framework, the study specifies the exchange rate volatility-non-oil export/import function as:

$$NOX/NOM = f(ERV, RP, WMC/DMC) \quad (2)$$

where:

NOX = non-oil export

NOM = non-oil import

ERV = exchange rate volatility

RP = relative prices

WMC = world import capacity

DMC = domestic economy's import capacity

To adjust exchange rate volatility to ensure that the variances are constant over time, this study followed Uma and Ikpe (2015) in adopting the Generalized Autoregressive Conditional Hetroscedasticity (GARCH, (p,q)) model. The model is specified as:

$$\sigma_1^2 = \alpha_0 + \sum_{i=1}^{p} \lambda_i \sigma_{t=i}^2 + \sum_{j=1}^{q} \gamma_j \mu_{t=j}^2 + \sum_{k=1}^{n} \beta_k \gamma_k \quad (3)$$

where:

σ_1

σ_{t-1}^2 = variance at time "t"

^{2} = previous period's variance

μ_{t-1} is squared lagged residual term

Furthermore, the above variance equation is modified so as to account for the non-negativity condition of the forecast estimates of conditional variance, and also solve the restriction problem of the GARCH model. For this purpose, the study follows Nelson's (1991) Generalized E-GARCH (p,q) model specified as:

$$\ln(\sigma_1^2) = \alpha + \sum_{i=1}^{p} \lambda_i \ln(\sigma_{t=i}^2) + \sum_{k=1}^{n} \beta_k \gamma_k + \sum_{j=1}^{q} \left[\omega_j \left| \frac{\mu_{t-j}}{\sigma_{t-j}} \right| + \theta_j \frac{\mu_{t-j}}{\sigma_{t-j}} \right]$$

α, λ_i, β_k, ω_j, θ_j are parameters to be estimated.

To model the causal relationship between exchange rate volatility and the set of variables in the non-oil export/import function, the study adopted the Vector Autoregressive (VAR) model. The general form of the model is specified as:

$$y_t = \beta_i + \alpha_i \sum_{j=1}^{k} y_{t=1} + \theta_i \sum_{j=1}^{k} X_t + \omega_t \quad (5)$$

where:

y_t = 4 × 1 vector of endogenous variables
X_t = 4 × 1 vector of explanatory variables
β_i = 4 × 1 vector of constants
α_i = 4 × 4 vector of coefficients matrix of the autoregressive terms
θ_i = 4 × 4 coefficient matrix of the explanatory variables
ω_t = vector of innovations,
j = lag length
k = maximum lag length

Intuitively, the reason behind the necessity for the GARCH (p,q) model is the fact that appreciation in exchange rate will likely lead to an upturn in certain macroeconomic variables like export, and a downturn in macroeconomic variables like import, where volatility is low. Likewise, depreciation in the exchange rate of a similar scale will result in minimal opposite effect under a volatile exchange rate regime (Cunado and Perez de Garcia, 2003). On the other hand, the suitability of the VAR model for the causal relationship is informed by the fact that it considers all variables as endogenous. By so doing it addresses possible simultaneity of problems, in addition to being able to not only explain but also predict and forecast values of sets of economic variables at any point in time. Furthermore, VAR has the ability to test for weak exogeneity and parameter restrictions.

4.2 Stationary properties of variables

In the model, all variables are considered endogenous. As a result, the VAR model was chosen for analysis; this necessitated the employment of the two-stage least squares (2SLS) and maximum likelihood estimation techniques. However, in order to ensure the constancy of variance over time, exchange rate volatility was (in the first instance) modelled using the GARCH (p,q) model.

The results of the stationarity properties of each of the variables in the model as specified in table 2 indicate that exchange rate volatility (ERV) is integrated of order zero (I(0); other variables are integrated of order one (I(I)). This obviated the need for the conventional test of cointegration, given that ERV and each set of the other non-oil trade indices are integrated of different orders. This justified the analysis herein on the basis of simple VAR estimates in all specifications (i.e., both non-oil import and export).

Table 2. Results of Stationarity Test

Variables	ADF statistics	1% Critical value	Stationarity state	Order of integration
Log(NOX)	-6.310574	-3.689194	Stationary	I(I)
Log(NOM)	-7.798921	-3.689194	Stationary	I(I)
GARCH-ERV	-224.7645	-3.679322	Stationary	I(0)
Log(RP)	-5.070652	-3.699871	Stationary	I(I)
Log(WMC)	-4.968383	-3.689194	Stationary	I(I)
Log(DMC)	-5.700606	-3.689194	Stationary	I(I)

4.3 Descriptive statistics

The results of the sets of descriptive statistics show that the hypothesis of normal distribution was rejected for non-oil import trade specification, given a JB statistics value of 4.111807, and probability value of 0.8469. The reverse was the case for non-oil export trade; this had a JB statistics value of 135.4455, and probability value of 0.0000. It should be noted that the JB statistics is a large sample test. The study sample of 30 observation periods may not necessarily be large in the context of JB statistics test definition. Furthermore, the residual correlation matrix for each of the non-oil trade specifications (tables 1a and 1b of the appendix) indicate the absence of serial correlation; all pair-wise matrices fall within the 0.8 rule of thumb mark. Interestingly, both non-oil trade specifications satisfied the VAR stability condition; unit circle presented in the appendix (table 2) indicate that no root lies outside the unit circle.

5. Result and Discussion

Major trade indices that accounted for changes in non-oil trade other than exchange rate volatility (ERV) include relative prices (RP), world import capacity (WMO) (for non-oil export trade), and domestic import capacity (DMC) (for non-oil import trade). Impulse response functions and variance decomposition trace the responses of each of the non-oil trade indices to one-time positive shocks on exchange rate volatility.

5.1 Effect of exchange rate volatility on non-oil export

Generally, the response of non-oil export to a unit positive shock on exchange rate volatility is negative and very minimal. This was infinitesimally felt between periods 2 to 3.5, after which it became muted. Its (NOX) responses to relative prices (RP) were however not different from what it was with respect to exchange rate volatility – i.e., negative minimal effect. The infinitesimal negative effect was felt between the first and fourth periods, beyond which it died out. On the other hand, the responses of this trade macroeconomic aggregate to a unit positive shock on world import capacity was more pronounced than what it was with either ERV or RP; with respect to ERV and RP, the effect was also negative. From an initial response in period one, the negative effects exhibited an increasing trend, which got to the peak in period two. Beyond the second period, this observed negative effect contracted and died out after period four and a half (see figure 1).

This suggests that a positive shock on exchange rate volatility leads to appreciation of the naira rate of exchange. In real terms, this effect significantly increases the capacity of Nigeria's trading partners to import goods and services, and also affects relative prices. In this context, non-oil exports become cheaper and more competitive internationally. Ordinarily, this would have improved the capacity of non-oil exports. Unfortunately, this is not the case because, exchange rate appreciation raises the domestic prices of imports, thereby increasing the cost of production for non-oil products.

Currently, Nigeria heavily relies on imported inputs for production in the non-oil sector. This translates to output reduction and increases in the unit prices of non-oil outputs. Through this mechanism, the competitive price gains, as well as gains in expanded world import capacity become eroded, hence the negative effects. Under this context, the magnitude of effect of exchange rate volatility on non-oil exports is defined by the margin by which competitive price gains offset higher unit prices from increased cost of production.

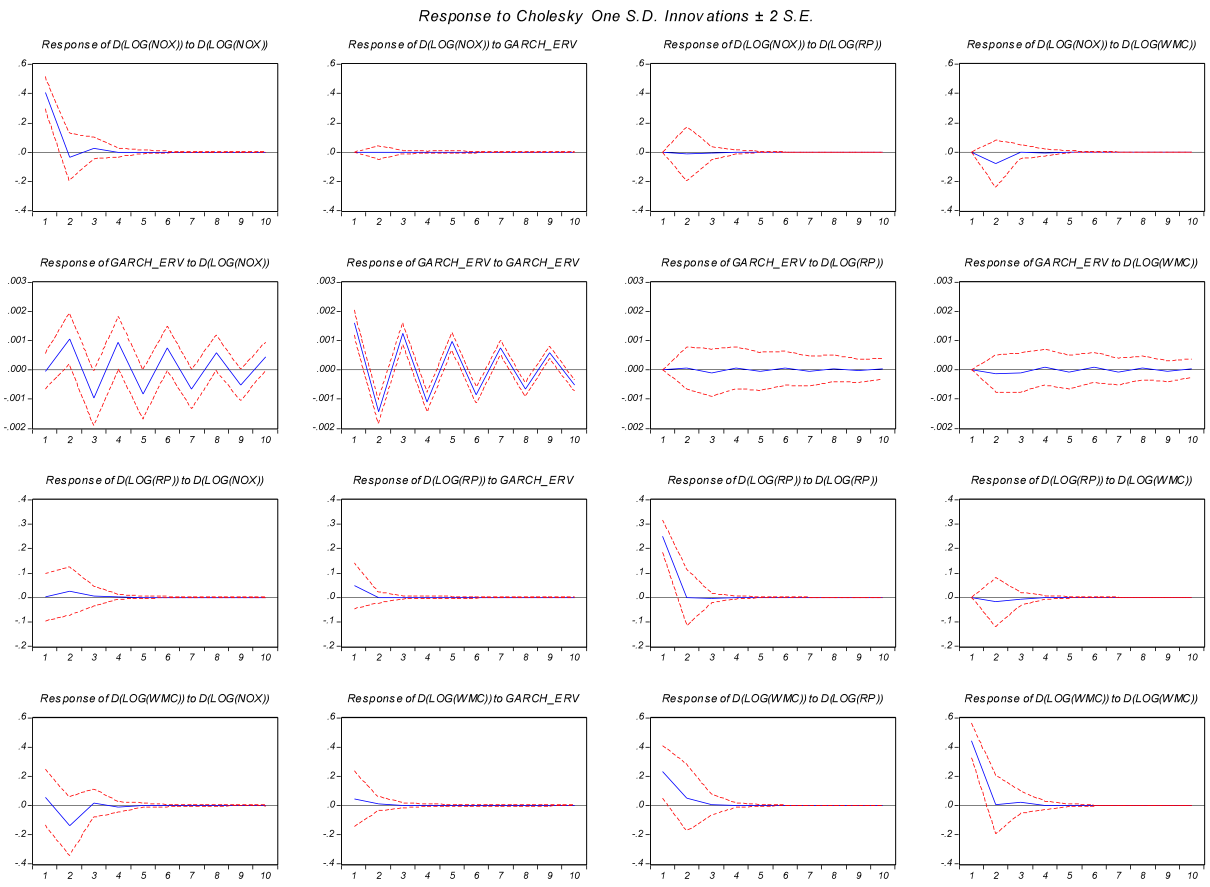

Figure 1. Responses of Non-oil Export to Exchange rate Volatility Shocks

Variance Decomposition

From the first row, columns 5, 6 and 7 of table 3 specify the forecast error variance decompositions of non-oil export as a result of one unit shock on exchange rate and other variables included in the non-oil export trade specification. From this, it is observed that variations in non-oil export as a result of positive shocks on exchange rate in the 2nd, 6th and 10th periods were 0.012, 0.014 and 0.015 respectively. A summary of the results indicates that (on average) 0.01% of changes in non-oil exports is explained by exchange rate volatility, 0.13% is accounted for by relative price, while world import capacity (WMC) explains 3.32%. An examination of the result shows that initial significant effect of a one-time positive shock on exchange rate, on non-oil export began in period two. The general observation is that this effect steadily increased across all periods at an infinitesimal rate, as there is no case of the effect being muted at any point.

Table 3. Variance Decomposition of Non-oil Export

Dependent variable	Period	Standard Error	NOX	ERV	RP	WMC
NOX	1	0.406254	100.00000	0.000000	0.000000	0.000000
	2	0.415643	96.18982	0.012247	0.098711	3.699223
	5	0.416794	96.14772	0.013681	0.144189	3.694412
	6	0.416795	96.14730	0.014084	0.144189	3.694432
	9	0.416798	96.14659	0.014824	0.144192	3.694391
	10	0.416798	96.14645	0.014972	0.144192	3.694382
ERV	1	0.001615	0.099258	99.90074	0.000000	0.000000
	2	0.002403	19.63468	80.00808	0.065750	0.291497
	5	0.003472	30.31362	69.15784	0.188440	0.340100
	6	0.003654	31.47603	67.98243	0.191105	0.350444
	9	0.003973	33.14596	66.29216	0.194926	0.366956
	10	0.004034	33.41964	66.01513	0.195537	0.369694
RP	1	0.255288	0.001514	3.518819	96.47967	0.000000
	2	0.257272	1.000758	3.465144	94.99819	0.535910
	5	0.257421	1.032334	3.461834	94.90470	0.601128
	6	0.257421	1.032355	3.461836	94.90468	0.60113
	9	0.257421	1.032357	3.461840	94.90467	0.601131
	10	0.257421	1.032358	3.46184	94.90467	0.601131

Dependent variable	Period	Standard Error	NOX	ERV	RP	WMC
WMC	1	0.505951	1.260549	0.843031	20.58506	77.31136
	2	0.527856	8.205274	0.829542	19.91675	71.04843
	5	0.528788	8.306165	0.82823	19.85898	71.00662
	6	0.528792	8.306892	0.828605	19.85874	71.00577
	9	0.528795	8.307399	0.829276	19.85848	71.00485
	10	0.528796	8.307482	0.82941	19.85843	71.00468

5.2 Effect of Exchange Rate Volatility on Non-oil Import

Non-oil import exhibited continuous positive and negative swings in its responses to one-unit shocks on exchange rate. From an initial minimal positive response observed in period 2, which became negative between period 3 and period 4, the aggregate continuously exhibited positive and negative responses to a unit positive shock on exchange rate in alternation. On the other hand, in response to a unit positive shock on relative prices (RP), non-oil import equally exhibited continuous positive and negative swings. The initial effect of shock on relative prices was felt in period 1, which was negative. This significant negative effect turned positive in period 3, and the swings continued. The observed positive and negative swings also characterized the responses of non-oil import to one unit shock on domestic import capacity (DMC). From an initial minimal positive effect in period 1, the aggregate exhibited alternating positive and negative responses to shocks on domestic import capacity. These are well elaborated in Figure 2.

Non-oil import exhibits the same pattern of responses to one time shock on each of the three indices of trade. This development finds explanation in the fact that exchange rate volatility affects non-oil import directly and indirectly through the other two indices of trade (DMC and RP). A positive shock on exchange rate causes the exchange of the naira to appreciate. This simultaneously raises the naira price of imported goods and lowers the foreign-currency price of all naira-denominated goods. These price impacts combine to shift world demand towards naira-denominated goods which has both immediate and secondary effects. While non-oil import responses to one time positive shock on exchange rate reflect the immediate (direct) effect, its responses to shocks on relative prices and domestic economy's import capacity account for the secondary (indirect) effects on non-oil import. Humpage (2008) had earlier argued that "given lags of inflationary monetary impulse, and the forward-looking nature of exchange markets, an economy's currency may depreciate in response to an excessive monetary policy before the prices of goods start to rise.

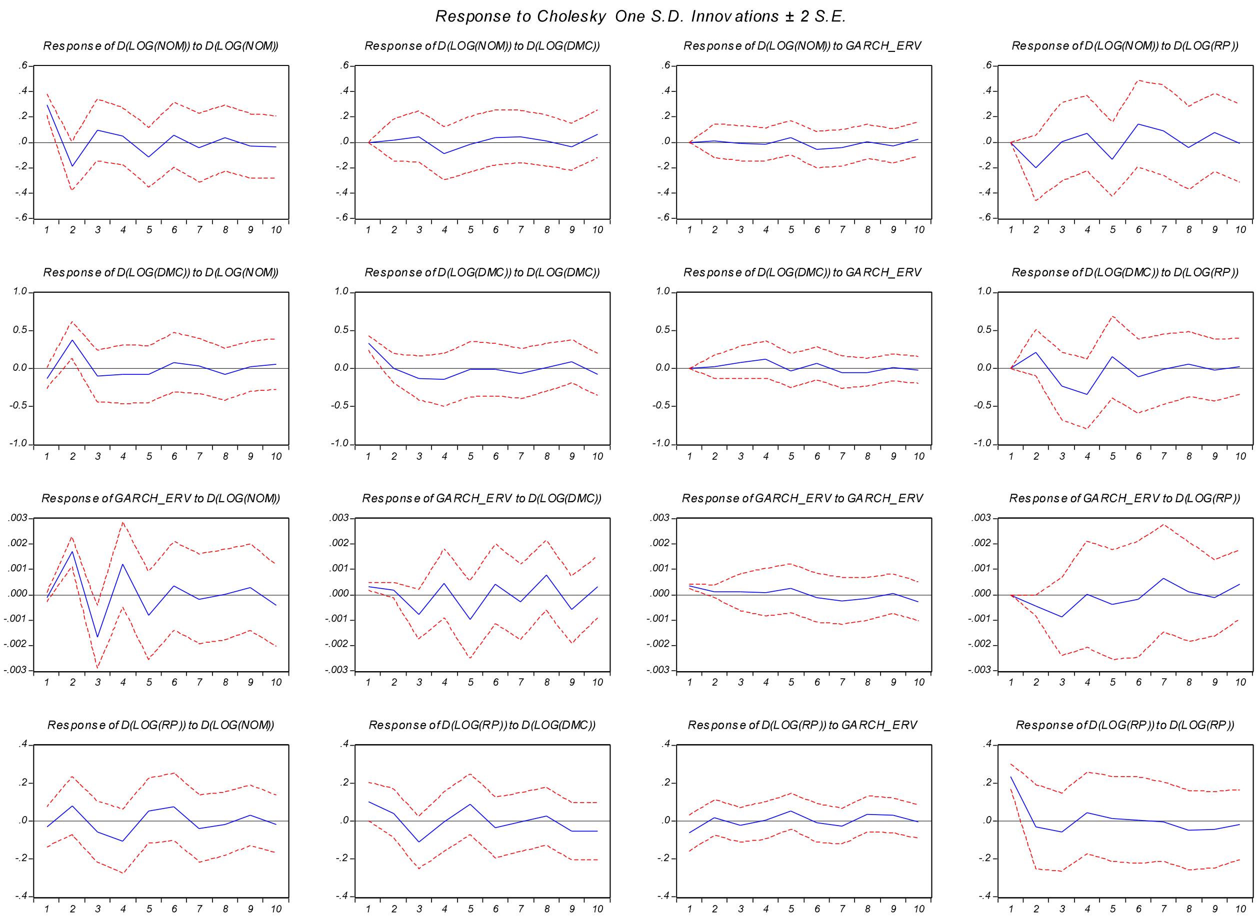

Figure 2. Responses of Non-oil Import to Exchange Rate Volatility Shocks

Variance Decomposition

The forecast error variance of the effect of exchange rate volatility on non-oil imports as elaborated in table 4 shows that variations in non-oil imports as a result of positive shock on exchange rate in the 2nd, 6th and 10th period are 0.071, 2.020 and 2.937 respectively. This indicates that on average, the explanatory power of exchange rate volatility in accounting for changes in non-oil import is 11.45%. Domestic economy import capacity accounts for 3.81%, while relative prices account for 27.6%. As was the case with non-oil exports, the significant effect of exchange rate volatility on non-oil imports began in period 2. Also, this was observed to be steady and progressive; the effect remained significant across the periods. Comparatively, the strength of the effect is more with respect to non-oil imports than exports. This tends to suggest that, generally, the effect of exchange rate volatility on non-oil trade is stronger on non-oil imports than exports.

Table 4. Variance Decomposition of Non-oil Import

Dependent variable	Period	Standard Error	Nom	ERV	RP	DMC
NOM	1	0.299962	100	0	0	0
	2	0.408417	74.8142	0.070483	24.91572	0.199603
	5	0.475769	66.205	0.097876	28.60626	4.482752
	6	505758	59.94229	2.019561	33.46543	4.572725
	9	0.531231	55.64039	2.816781	36.15584	5.386994
	10	0.537331	54.87195	2.937204	35.36188	6.828962
ERV	1	0.0005	4.84521	48.5036	0	46.65119
	2	0.00184	86.36711	3.805835	5.640627	4.186429
	5	0.00332	70.68407	1.883194	9.988107	17.44463
	6	0.00337	69.58803	1.967001	9.98133	18.46364
	9	0.00361	61.50189	2.405464	12.12127	23.97138
	10	0.00368	60.47292	2.8459	12.93293	23.74826
RP	1	0.264699	1.459495	5.678032	77.74394	15.11853
	2	0.281661	9.316625	5.433877	69.84706	15.40244
	5	0.35471	19.802	5.87634	48.33715	25.98451
	6	0.364494	22.97611	5.649383	45.79347	25.58104
	9	0.383099	22.68165	7.155191	44.53169	25.63147
	10	0.387578	22.35168	7.001772	43.76108	26.88547

Dependent variable	Period	Standard Error	Nom	ERV	RP	DMC
DMC	1	0.359926	12.6958	0	0	97.3042
	2	0.561141	50.34206	0.141097	13.59824	35.91861
	5	0.765613	30.7237	3.706888	39.72823	25.84118
	6	0.780151	30.70771	4.307051	40.06458	24.92066
	9	0.798861	30.45385	4.888021	38.79394	25.86419
	10	0.805608	30.46363	4.880365	38.26543	26.39058

6. Policy Implications, Conclusion and Recommendation

6.1 Policy implications of findings

A good number of previous Nigeria-specific studies failed to consider possible endogeneity between exchange rate and trade flows, and therefore did not employ appropriate econometric models. It is on that premise that this investigation was embarked upon. This paper therefore analysed the dynamic responses of non-oil trade macroeconomic aggregates to shocks on exchange rate in Nigeria using the GARCH(p,q)-VAR analytical method of estimation. Results show that while non-oil import continuously exhibited positive and negative swings in response to shocks on exchange rate, the effect on non-oil export was negative and quite minimal, and subsequently became insignificant afterwards. Comparatively, this indicates that the effect of exchange rate volatility is felt more on non-oil imports than exports, but it is also erratic in its behaviour. The fluctuating response observed in non-oil imports is in consonance with the proposition by both the IMF (1984) and Auboin and Ruta (2013) that "fluctuations in exchange rate induce a high degree of uncertainty in international transactions". On the basis of the above findings, relevant policy implications are drawn and relate as follows:

- *Exchange rate volatility exerts a negative but minimal effect on non-oil export:* Policy wise, this implies that Nigeria stands to gain if current efforts on export value chain are diligently stepped up through the establishment of functional industrial clusters in each of the geo-political zones. These shall be made up of firms engaged in the processing of agricultural produce, and output of the mining sector. This idea is primarily to make the task of providing power for industrial use easier and more attainable given that they will be provided with exclusive source of power for industrial use. This has the tendency to reduce the cost of producing non-oil produce, and ensure that the economy derives the benefits of competitive price gains occasioned by the appreciation of exchange rates.

- *Exchange rate volatility affects import directly and indirectly through domestic import capacity (DMC), and relative prices (RP):* The implication of this for policy is that the economy could regulate the volume of non-oil imports directly through effective monetary and exchange rate policy measures, and indirectly through measures aimed at depressing the economy's level of domestic import capacity. To this end, the establishment of industrial clusters as a way of gaining competitive price advantage becomes one measure that serves dual purposes; in addition to making non-oil exports internationally competitive, it also provides price-competitive domestic substitutes for imported non-oil products.

6.2 Conclusion and recommendation

The above analysis leads this study to conclude that the observed negative effect of positive shocks on exchange rate on export points to the fact that a devaluation policy will be counter-productive for Nigeria, given the underdeveloped state of the non-oil sector. From all indications, competitive price gain occasioned by appreciation in exchange rate has the tendency to be eroded by the resultant increased domestic cost of production through a secondary channel. This result is consistent with findings by Anthony (2008), Aliyu (2009) and Olufayo and Fagite (2014), but inconsistent with findings by Oyorwi and Ukarwe (2013), and Akinlo and Adejumo (2014) – all studies on Nigeria. Furthermore, the study concludes that, exclusive reliance on exchange rate as a trade policy management tool in the non-oil sector in the current period can be counter-productive for Nigeria, given the under-developed state of the non-oil industrial sector. However, this challenge can be overcome through the establishment of industrial clusters. Functional industrial clusters will increase the economy's capacity to produce domestic substitutes for imported non-oil manufacturers at competitive price rates, and this is therefore highly recommended for the capacity building of the non-oil sector.

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APPENDIX

Table 1a. Residual Correlation Matrix for Effect of ERV on NOX

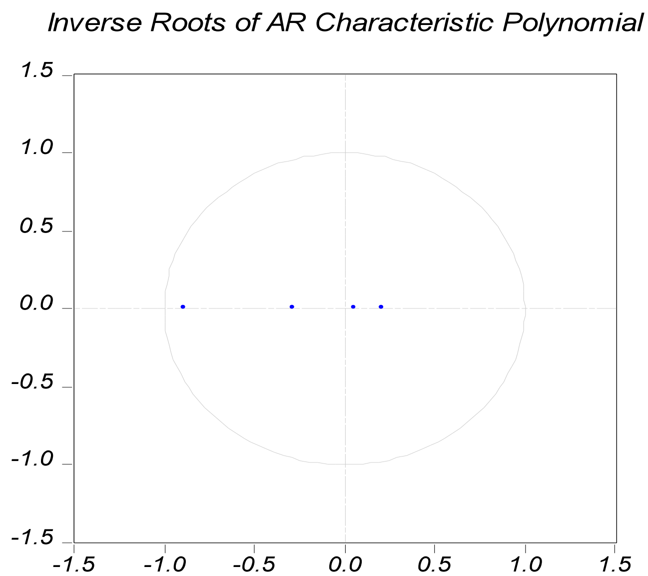
	NOX	ERV	RP	WMC
NOX	1	0.212421	0.460753	0.092771
ERV	0.212421	1	0.133534	-0.324737
RP	0.460753	0.133534	1	0.260286
WMC	0.092771	-0.324737	0.260286	1

Table 1b. Residual Correlation Matrix for Effect of ERV on NOM

	NOM	DMC	ERV	RP
NOM	1	-0.496453	-0.007412	0.050506
DMC	-0.496453	1	0.127969	0.155844
ERV	-0.007412	0.127969	1	0.166225
RP	0.050506	0.155844	0.166225	1

VAR Stability Tests

Table 2a. Effect of Exchange Rate Volatility on Non-oil Export

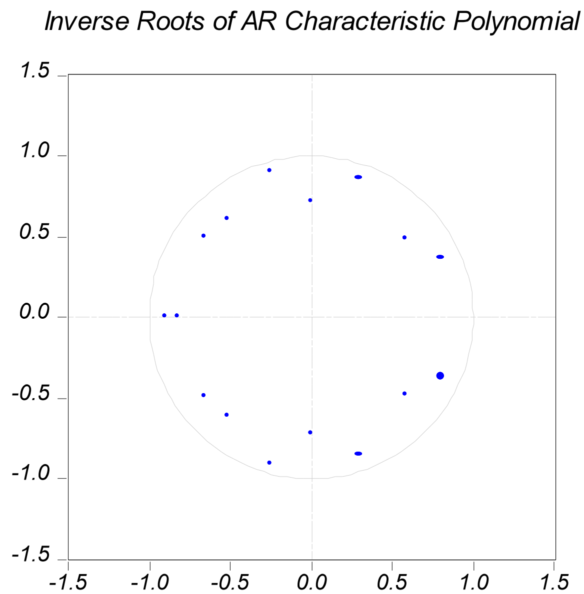


Roots of Characteristic Polynomial
Endogenous variables: D(LOG(NOX)) GARCH_ERV D(LOG(RP)) D(LOG(WMC))
Exogenous variables: C
Lag specification: 1 1
Date: 12/15/17 Time: 19:14

Root	Modulus
-0.883689	0.883689
-0.281462	0.281462
0.211435	0.211435
0.061675	0.061675

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 2b. Effect of Exchange Rate Volatility on Non-oil Import



Roots of Characteristic Polynomial
Endogenous variables: D(LOG(NOM)) D(LOG(DMC)) GARCH_ERV D(LOG(RP))
Exogenous variables: C
Lag specification: 1 4
Date: 12/15/17 Time: 19:35

Root	Modulus
-0.249154 - 0.904858i	0.938534
-0.249154 + 0.904858i	0.938534
0.295108 - 0.857802i	0.907145
0.295108 + 0.857802i	0.907145
-0.894019	0.894019
0.799713 - 0.364303i	0.878782
0.799713 + 0.364303i	0.878782
-0.656087 - 0.493607i	0.821034
-0.656087 + 0.493607i	0.821034
-0.819078	0.819078
-0.508301 - 0.609474i	0.793617
-0.508301 + 0.609474i	0.793617
0.583691 - 0.482963i	0.757594
0.583691 + 0.482963i	0.757594
0.005423 - 0.717154i	0.717174
0.005423 + 0.717154i	0.717174

No root lies outside the unit circle.

VAR satisfies the stability condition.