# ANALYSING TERMS OF TRADE VOLATILITY FOR NIGERIA: DO TERMS OF TRADE VOLATILITY HAVE ASYMMETRIC EFFECTS IN NIGERIA

**Emmanuel Ojochenemi Akor**
Department of Economics,
Faculty of the Social Sciences
University of Nigeria, Nsukka
emmanuelakar001@gmail.com

## ABSTRACT

Nigeria is often susceptible to volatile terms of trade due to its dependence on primary commodities with unstable prices. This study, therefore, made its contribution to literature by empirically analysing terms of trade volatility in Nigeria.

This study used quarterly time series data ranging from 1981Q1 to 2016Q4, obtained from the World Bank (2017) database. Asymmetries in terms of trade volatility were determined by applying the TGARCH (1, 1) model. The study revealed that terms of trade entail asymmetric effects, suggesting that bad times of adverse terms of trade shocks have a more pronounced effect than it does in good times.

The empirical findings mainly imply, amongst other things, that to reduce terms of trade volatility, Nigeria needs to imbibe the political will to save through fiscal discipline and instituting a strong competent framework, to enable her to stabilize the economy in situations of adverse shocks. The government should also encourage indigenous producers by providing and investing in a conducive environment that will reduce the cost of production and enable businesses to thrive.

# 1. Introduction

Every country is inclined to produce goods and services that will satisfy both local and foreign markets. International trade has therefore increased productivity by inducing countries to specialize in the areas in which they possess relative comparative cost advantage, however, how much an economy gains from trade is a function of its terms of trade which is defined as the price of its exports relative to the price of its imports. It indicates the level of exports that can be sold to acquire more imports and hence changes in the terms of trade tends to affect the macroeconomic performance of a country. Terms of trade volatility are unpredictable and unanticipated events that have an either negative or positive effect on the economy and can rationally lead to revenue fluctuations which are the major factors that give rise to macroeconomic volatility (Agenor & Aizeneman, 2003).

Over the years, Nigeria has experienced many external shocks due to volatile terms of trade. These external shocks can be described as a double-edged sword because they affect the economic performance in positive (booms) and negative (bursts) terms. In sub-Saharan Africa, there are numerous conditions of high dependence of economic performance on the external environment and amongst these conditions which are outside the control of policymakers, are the terms of trade and volatility of the markets for its exports (Mkandawire & Soludo, 1998). Since independence, Nigeria has focused on export revenues from one or few primary products that are extremely vulnerable to terms of trade and demand conditions; this over-reliance on primary products for foreign earnings and fiscal revenue is further worsened by an ineffective industrial sector, which has been relegated as a result of crude oil discovery.

As pointed out by Broda and Tille (2003), developing nations that rely on primary commodity exports whose values are volatile, and always susceptible to sharp swings in their terms of trade, which will affect a large portion of their economies. Volatility does kill planning for policymakers and the federal

government that rely on exports earnings to manage its fiscal responsibilities, subsidies and other expenditures that concern the provision of welfare. The volatility problem most times lead to budget deficits and debt problems where huge sums are borrowed to finance aggregate consumption. It appears that price fluctuations have a tremendous influence on welfare programmes of Nigeria (Madueme & Nwosu, 2010).

Addison (2007) compared Nigeria and other countries in terms of volatility and reported that Nigeria ranked third out of 90 sample observations in terms of volatility of annual changes in terms of trade index between the periods of 1991-2000 sample mean. This volatility problem harms the macroeconomic level of the country; output growth and the return on investment in private sectors. Shocks to terms of trade in Nigeria have given rise to inconsistencies in output, inflation and exchange rate (Ngwudiobu, 2016). The uncertainties created by volatile terms of trade makes it difficult for indigenous industries and project managers to implement rational decisions such as what to produce, how to produce and technique or method to use.  In the same vein, Ngwudiobu, Emecheta and Aidi (2016) asserted that volatility in the real exchange rate is common in countries with high frequency terms of trade shocks; as a result investors who are risk aversive are often lackadaisical towards putting funds into any venture until they are able to forecast their return on investment, which of course will depend on macroeconomic indicators that are vulnerable to terms of trade shocks.

The uncertainty issue in terms of trade has led to different debates on adequate policies that can ameliorate or manage external shocks. Cashin and Pattillo (2000) suggested that an economy cannot embark on economic policy without perfect knowledge of the uncertainty that lies in her terms of trade variations. This has triggered the formulation of strategies that will enable countries to cope with adverse terms of trade volatility; one of these strategies is the self-insurance approach which, according to Ray (1998), uses accumulated savings to smooth uncertain shocks to income. The self-insurance strategy can come in the form of a commodity price stabilization

fund, like the Sovereign Wealth Fund (SWF) that serves as economic buffers or a set benchmark on the amount of money the government can spend out of its income that it earns from a major commodity or having a higher savings rate under periods of booms and also staying away from long-term projects that could lead to sunk cost when there is an adverse shock in the future.

Furthermore, according to the permanent income hypothesis, people save when they expect their income to decline; moreover, informal knowledge suggests that terms of trade shocks might entail asymmetric response in savings (Agenor & Aizenman, 2003), because of the inability of good times to counteract the adverse consequences created by bad times. Thus, at this point, it becomes pertinent to ascertain the asymmetry in terms of trade uncertainties; to know whether bad times have a more pronounced effect than it does in good times. Asymmetries tend to create motivation for precautionary savings because, in situations of adverse shocks, consumption can be smoothed by running down previously accumulated national savings (Deaton, 1990).

Irregularities in terms of trade tend to take the economy by surprise, hence, comprehending the dynamics of terms of trade and its volatility, predicting and managing its consequences/effects become necessary and require due attention. The rest of this paper is outlined as follows; section 2 reviews relevant literature; Section 3 discusses the methodology; Section 4 presents the analysis and interpretation of findings, and section 5 provides the recommendation and conclusion.


## 2.    Review of Relevant Literature.

Conceptually, The Economist (2006) defined terms of trade as the ratio of an index of a country's export prices ($P_x$) to an index of its import prices ($P_m$). The terms of trade position of a country is said to improve if this ratio increases

and deteriorates, if otherwise. This definition may also be embellished given this equation.

$$TOT = \left(\frac{P_x}{P_m}\right)100 \;......................................................................\; (2.1)$$

The equation above can be explained by the numerator and denominator components, which are given as the price basket of commodities exported and imported from a given country. The numerator component of the equation ($P_x$) shows that a given basket of exports is formulated in such a way that the most popular exports of a country are culminated in this basket and weighted according to the revenue generated and thus we arrive at a weighted average of export prices. On the other hand, the denominator component ($P_m$) is treated as the prices of imports consumed by a nation, weighted accordingly, given the expenditures from imports and hence, the entire basket of imports becomes a weighted average of import prices.

Volatility is derived from the word "volatile" meaning something that tends to vary often or widely. The concept of volatility is often used in mainstream economics alongside business cycles and most times interchangeably used as uncertainty, risk, variability, oscillations and fluctuations, and in most cases, shocks. For example, a shock signifies a sudden, unanticipated and unpredictable event that has either positive or negative consequences on the economy. On the other hand, volatility implies rapid and unanticipated variations over time. Although shocks are volatile, not all volatilities are shocks; there are a lot of ambiguities emanating from words used alongside volatility, either they are applied synonymously or even viewed as implications such as crisis, fragility, and vulnerability.

According to Black (2002), volatility refers to the fluctuations in the value of a random variable, especially price. It can be historical, based on a model or forecast. It can also be cyclical, persistent or mean-reverting. It is usually measured by standard deviations and can be seen as movements of a random variable by an amount which is liable to change upwards or

otherwise during a given time frame, perhaps a year. For this study, volatility will be expressed indirectly as variability and uncertainty. The former implies all movements both deterministic and random while the latter refers to the stochastic trends.

### i. Prebisch-Singer Hypothesis

The Prebisch- Singer hypothesis argue that the prices for primary commodities will in the long-run face a decline in the international market for its exports as a result of its low price/income elasticity and also because producers of inexpensive primary products tend to consume disproportionate amounts of manufactured imports.

This theory dwells on the income elasticity of demand for exports and imports in less developed countries and the driving force is the wealth effect. The argument for this is that, exports of natural resources from developing countries are income inelastic because when the world income rises, there would be an increase in demand for primary commodities though infinitesimal; they are classed as necessity goods because only a small portion of income is spent for the commodity and few substitutes (Fatima, 2010). Thus, when the income of consumers changes, it does not significantly vary consumption. On the other hand, the imports which are semi-finished or finished (capital) goods are income elastic. For instance, when people experience increases in their income, they demand a lot more of what developed economies export, that is, manufactured goods.

Hence, in the long run, there will be a massive rise in global output/ income growth and average income as a result of increased demand for manufactured goods, culminating in the increased price of manufactured goods relative to the price of primary products. The Prebisch-Singer thesis argues that as a result of this disparity or difference in elasticity, the plausible way out from this undue dependence on natural resource is for developing economies to take advantage of transitory improvements in their terms of trade.

## ii. The Dutch Disease Theory

In mainstream economics, the Dutch disease is referred to as the de-industrialization of a nation's economy which happens when there is the discovery of a natural resource; this event makes the country's currency appreciate and manufactured goods become less competitive compared to other nations thereby increasing imports and decreasing exports. The Dutch disease theory is chiefly credited to Corden and Neary (1982) who analysed its effect on a small open economy that experienced de-industrialization due to the natural resource discovery.

According to Krugman (1987), the Dutch disease induces a reduction of the economy's external competitiveness in other industrial sectors because the primary commodity-based export tends to crowd out manufactured based-commodity exports produced by these sectors. Over time the economy will begin to face economic downturns in key development areas in which only the manufacturing sectors can salvage (Kaldor, 1981). Hence, crowding out the manufacturing sector can have its repercussions in the long-run; for example, if the natural resource begins to deplete or an adverse price shock hits the market for primary products, the manufacturing sector may not respond so swiftly to ameliorate the crisis.

Speaking on the volatility in the market for primary commodities and how rapid their prices tend to fluctuate, the effect is often a double-edged sword that cut both ways; it could be either adverse or an improvement in terms of trade. Although to Corden et al (1982), the effect of the Dutch disease is split into two; the resource movement effect and spending effect. The former refers to an increase in the value of additional output of labour which is induced as a result upward spike in price, pushing the equilibrium rate of wage upwards. This will trigger the transfer of labour away from the industrial sector to the newly discovered primary sector. On the other hand, the latter refers to an increase in income due to the rise in the global price of the

natural resource and as a result, imports for exotic manufactures will shoot up.

The basic solution to ameliorate this disease is could be connecting the bridge between terms of trade uncertainties and national savings.  One basic step could be to reduce the amount of natural resource income that is brought into the country all at once; saving portions of the income in a special national savings account abroad and bring them into the economy in instalments. This act is known as the sterilization process which helps to reduce spending effect, create a stabilized income stream and also encourages saving part of revenues as a buffer during adversities.

## 3.    Methodology

In constructing a valid measure of volatility, it is pertinent to differentiate between ordinary variability and true uncertainty so as to generate a measure that represents only the unpredictable innovations in the terms of trade; furthermore, in order to examine the effect of uncertainty on the dependent variable it is also important to generate a time-variant level of uncertainty and thus to generate a variable conceptually comparable to this description of uncertainty, it becomes necessary to apply the GARCH model to the innovations in the terms of trade introduced by Bollerslev (1986).

However, according to Dimitrois and Hall (2006), a major setback of ARCH/GARCH model is the fact that they are symmetric. This posits that the absolute value of the innovation alone is taken into cognisance and not its signs and this occurs as a result of squaring the residual terms. Hence, big positive shocks will have the same effect in the volatility series as big negative shocks of the same magnitude. To solve this setback, the Threshold Generalized Autoregressive Conditional Heteroskedasticity (TGARCH) was introduced by Zakioan and Rabemananjara (1993); Glosten, Jaganthan and

Runkle (1993) with the specific aim to capture the asymmetries in terms of negative and positive shocks. A TGARCH $(1,1)$ process is specified as;

$$h_t = \alpha_0 + \alpha_1 \mu^2_{t-1} + \lambda_1 d_{t-1} \mu^2_{t-1} + \beta_1 h_{t-1} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (3.1)$$

$$d_{t-1} = 1 \; if \; \mu_{t-1} < 0, d_{t-1} = 0 \, if \, \mu_{t-1} \geq 0, \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (3.1a)$$

The only difference between the GARCH and TGARCH models is the inclusion of a dummy variable $(d_{t-1})$, which represents shocks/volatility observed in previous periods and is equal to one (1) if the error term of previous periods is less than zero ($\mu^2_{t-1} < 0$), and is zero (0) if otherwise ($\mu_{t-1} \geq 0$). The logic behind the TGARCH model is that positive figures of $\mu_{t-1}$ are linked with a zero value of the dummy variable $(d_{t-1})$ therefore if $\mu_{t-1} \geq 0$, shocks to the conditional variance ($h_t$) will be $\alpha_1 \mu^2_{t-1}$. When $\mu_{t-1} < 0 \; (that \; is, d_{t-1} = 1)$ the effect of shock on $h_t$ will be $(\alpha_1 + \lambda_1) \mu^2_{t-1}$. If $\lambda_1 > 0$, then, negative shocks have a larger effect on volatility than positive shocks. In summary, the TGARCH model involves an addition of a multiplicative dummy variable to the variance equation so as to check if there is a statistically significant difference when shocks are negative; when the product of $d_{t-1} \mu^2_{t-1}$ is taken and the coefficient is statistically different from zero, then it can be concluded that the data entails asymmetric effects.

The objective of this paper is to determine whether terms of trade volatility have asymmetric effects in Nigeria. To capture this objective, the TGARCH model framework by Glosten, Jaganthan, and Runkle (1993) will be employed. The mean equation of the model will be;

$$InTOT_t = \alpha + \beta \; In \; TOT_{t-1} + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
(3.2)

Equation (3.2) depicts the mean equation which shows the regression of current period terms of trade ($InTOT_t$) on its lag ($In \; TOT_{t-1}$), where α represent the constant and β is the 1st order autoregressive coefficient of the

dependent variable. $\mu_t$ is the error term which is assumed to be normally distributed with zero mean and a constant variance. However, the constant variance is denoted as;

$$h_t \, In \, TOT \; = \; \alpha_0 \; + \; \alpha_1 \mu^2_{t-1} + \lambda_1 d_{t-1} \mu^2_{t-1} + \beta_1 h_{t-1} In \, TOT \; \dots\dots\dots\dots\dots\dots\dots\dots \quad (3.3)$$

$$d_{t-1} \; = \; 1 \, if \, \mu_{t-1} \, < \, 0, d_{t-1} \; = \; 0 \, if \, \mu_{t-1} \, \geq \, 0, \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
(3.3a)

The equation above (3.3) is the conditional variance for the terms of trade which can be referred to as the terms of trade volatility is equal to the constant $(\alpha_0), \mu^2_{t-1}$ is the lag of squared error term which captures data volatility/shocks observed in previous period volatility and its coefficient α1 is represented as the ARCH (1) process while $\beta_1$ which is the coefficient of the previous terms of trade volatility ($h_{t-1} In \, TOT$) [GARCH (1) process]. Finally, $\lambda_1$ captures the asymmetric (threshold) effect; $d_{t-1}$ is the multiplicative dummy which is added to the variance equation to check whether there is a statistically significant difference when shocks are negative. With reference to equation (3.1a), the dummy $d_{t-1}$ is equal to one if $\mu^2_{t-1}$ less than zero and, equal to zero if $\mu^2_{t-1}$ greater than or equal to zero.

It is important to also note that since the study is employing the ARCH family of models, it becomes necessary to check for the presence of ARCH effects to know whether the mean equation has properties of conditional variance to proceed to the variance equation.

## 4.    Presentation of Results and Data Analysis

Before estimating the models specified in the previous section, it was necessary to conduct a unit root test to know the order of integration for every variable in the model. The Augmented Dickey-Fuller (ADF) procedure was followed

This section starts by showing the unit root result of the series which embodies the model make up for ascertaining whether terms of trade have asymmetric effects in Nigeria.

**TABLE 4.5 SUMMARY OF ADF UNIT ROOT OF THE SERIES FOR MODEL THREE**

| VARIABLE | ADF STATISTICS (LEVEL) | MACKINNON CRITICAL VALUE @ 5% | ADF STATISTICS (1ST DIFF) | MACKINNON CRITICAL VALUE@5% | ORDER OF INTEGRATION |
|---|---|---|---|---|---|
| LTOT | 0.484544 | 1.943229 | 3.160528 | 1.943221 | I(1) |

*SOURCE: Author's computation using e-views 9*

From Table 4.31 above, the log of terms of trade (LTOT) is integrated of order one.

## 4.1 Testing for ARCH Effect

After estimating the LTOT on a constant and on a lag of itself, that is LTOT (-1), using the least square method, the correlogram test for the squared residuals indicated an insignificant correlation from the first two lag. The first order autocorrelation was 0.4999 and after the second lag, it became significant down to the lag 36. The citation by Mc leod-Li (1983) as seen in Enders (2015) opined that the heteroskedasticity test for ARCH should be based on four lags when dealing with quarterly data series. Hence, having conducted the test for ARCH effect, the observed R- squared statistics is 32.28223 with a corresponding probability value, which was statistically significant; indicating that "there is ARCH effect". Finally, the normality test for standardized residuals depicted that AR (-1) is not normally distributed; showing a large kurtosis value of 8.138433 (which is above the conventional threshold of 3), coupled

with a negative skewness of -0.422288. The general pattern of the series indicated a case for conditional heteroskedasticity and hence the TARCH model was applied.

**TABLE 4.1    TGARCH (1, 1) RESULTS**

| MEAN EQUATION | | | | |
|---|---|---|---|---|
| VARIABLES | COEFFICIENTS | STD. ERRORS | Z-STATS | PROBABILITY |
| C | -0.0000179 | 0.003216 | 0.005556 | 0.9956 |
| LTOT | 0.775357 | 0.083644 | 9.269679 | 0.000 |
| VARIANCE EQUATION | | | | |
| C | 0.000274 | 0.0000523 | 5.215056 | 0.0000 |
| ARCH (-1) | 0.526528 | 0.205959 | 2.556467 | 0.0106 |
| TARCH(-1)<0 | 0.636682 | 0.287046 | 2.218051 | 0.0266 |
| GARCH (-1) | 0.466379 | 0.081643 | 5.712427 | 0.0000 |
| D(GDS) | 0.000161 | 0.0000637 | 2.532243 | 0.0113 |
| R-SQUARED 0.317192 | | | DURBIN WATSON | 2.421445 |
| ADJ                R-SQUARED 0.312315 | | | | |

*SOURCES: Author's computation using e-view 9*

From Table 4.32, the ARCH and GARCH coefficients (0.5265 and 0.4664) are statistically significant. Also, the TARCH coefficient which captures the asymmetric effect indicates that there is a statistically significant difference when shocks are negative; the TARCH coefficient which is not just significant but positive shows that indeed terms of trade volatility have asymmetries in

different periods. Specifically, negative periods have larger effects on the volatility of the series relative to positive periods. Finally, national savings show a statistically significant result. This is an indication that an increase in the impact of previous periods (last quarter) of national savings on the average, increase terms of trade volatility by 0.002 per cent, holding the influence of other variables constant.

**DIAGNOSTIC CHECKING FOR TGARCH (1, 1)**

In order to test the ARCH effect of the above TARCH estimation, the ARCH-LM Heteroskedasticity Test was performed as shown below.

**TABLE 4.2     ARCH-LM HETEROSKEDASTICITY TEST**

| F-STATISTICS | PROB. |
|---|---|
| 0.116745 | 0.7331 |
| OBS*R                          SQUARED | PROB. |
| 0.118326 | 0.7309 |

*Source: Author's computation using e-views 9*

After conducting the ARCH-LM test, the probability value shown in the table above, is above the significance threshold, hence, the null hypothesis which states that "there is no ARCH effect" at 5% significance level is accepted. In a different light, having tested for serial correlation using the correlogram Q-statistics for the squared standardized residuals and observed that only the first three lags are statistically insignificant (that is, from lag 4 – lag 36 tested statistically significant); we conclude that there is no much serial correlation in the TARCH estimation result. Also, the normality test for the standardized residuals is not normally distributed as it shows a high kurtosis of 6.893739 and also a statistically significant Jarque Bera Statistics.

**POLICY IMPLICATIONS OF FINDINGS**

Hypothesis 1 ($H_{01}$): Terms of trade volatility have no asymmetric effects in Nigeria.

Conclusion: The section of empirical analysis (table 4.1) revealed that the TGARCH coefficient, which indicates the asymmetric effects is positive and statistically significant, in accordance with the 5% significant level decision rule. Hence, we reject the null hypothesis and conclude that terms of trade volatility have asymmetric effects in Nigeria.

From the result, terms of trade volatility was found to have asymmetric effects in Nigeria; this implies there is asymmetry in terms of trade uncertainties and therefore adverse periods of terms of trade volatility will have a more pronounced effect than good periods of boom. It becomes viable at this point to suggest that more attention is committed toward accumulating savings for the propose of stabilization; asymmetries tend to create motivation for precautionary savings because, in situations of adverse shocks, consumption can be smoothed by running down previously accumulated national savings (Deaton, 1990).

## 5.     RECOMMENDATIONS AND CONCLUSION

Based on the findings of this study, some policies that would help Nigeria in achieving the overall objective of cushioning the effect of volatile terms of trade are discussed:

It is a conventional knowledge that Nigeria tends to treat good times as permanent and negative times as transitory due to the unwillingness to save. However, the best policy option would be to assume all shocks (whether positive or negative) as temporary; saving all excessive revenues irrespective of price/ budget benchmarks and also sterilizing the impact on the money supply by building up foreign assets. Although, the government may find it

difficult to resist the pressure to spend in the face of mounting revenues and also to make cuts when revenue falls, hence, strong and quality institutional frameworks should be instituted with autonomy and devoid of any political manipulation

One of the major reasons for the extreme terms of trade crisis in Nigeria is the primary and concentrated nature of her exports compared to its well-diversified imports. Unlike most developed countries, Nigeria is usually not in the position to determine the price of its export and imports, however, it can reduce terms of trade volatility by overhauling its composition of either exports or imports or both. In this case, it would be inconsequential for Nigeria to focus on its already diversified imports, hence the need for diversification of exports into output and price trends that are uncorrelated with volatile oil prices. Taking a cue from Indonesia, who use to be a major oil exporter was able to successfully diversify her output and exports and also cut terms of trade volatility by 50% within one decade (Addison, 2007).

For efforts at export diversification to be achieved, supportive attention is needed especially in terms of creating an enabling environment for indigenous manufacturers; imagine if the city of Aba had constant electricity? Nigeria has a large indigenous market of over 190 million people; this proffers an advantage to those who might invest in manufacturers that depend upon economies of scale for profitability. To buttress this point, existing literature has shown that such cases allow for easier export penetration and most of all manufactures have fairly less volatile international prices. Subscribing to the words of Moghalu (2013), Africa (Nigeria inclusive) needs an endogenous growth model in which it manufactures goods for its markets as a first foundation, spreading out regionally from that base and emerging as an economic force in its own right through competitive advantage.

Other researchers have viewed terms of trade from the angle of its interaction with inflation, real exchange rate, output and institutional quality

(see Mendoza, 1995; Rodrik, 1999; Ngwudiobu, Emecheta & Aidi, 2016). However, the analysis of terms of trade effect is also important because it presents a panacea for reducing volatility and would open the eyes of government to the pressing need of saving for future generations and the circumspection that there is need for a fundamental shift from consumption to production; according to Deaton (1990), in such a world of volatility of commodity prices, the government would have to play the custodian role both as guardians of the future generations and as an insurance company, to protect the present generation' consumption. This study, therefore, solicits that policymakers should, henceforth, take frenetic steps towards checkmating terms of trade disturbances; having a reorientation towards savings and also engaging in policy thrust that would instil fiscal discipline regardless of revenue outcomes.

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