

The Volatility of International Commodity Prices and Aggregate Output Vulnerability: Policy Options for Mitigation

***Olotu, M. E.**

Nsonwu, M.

Jegbefumwem, K.

Department of Economics, Novena University, Ogume, Delta State, Nigeria

**E-mail: efeolotu@gmail.com*

ABSTRACT

From the period of independence till date, Nigeria has synchronized requisite macroeconomic framework to accelerate the pace of economic growth. Unfortunately, the continuum of progress experienced is not always sustained. To resuscitate the economy and place it on a steady growth path, a virile macroeconomic policy is necessary. This requires a compact empirical quantification of what drives fluctuation in aggregate output. While theory underpins it to exogenous shocks from international price of primary export and sudden stops to capital inflows, the economy's self-inflicted policy mistake is also liable. It is in light of this preoccupation that this study is conducted to examine the extent to which aggregate output is vulnerable to volatility in international commodity prices using a variant of the Sensitivity Model. From the result, the exposure of the economy to exogenous shocks (oil price and terms of trade) accentuates the vulnerability of aggregate output. Of the domestic variables employed, only fiscal balance proves significant. Contrary to expectation, money supply and interest rate are not statistically different from zero. If the economy must be purged of its high level of vulnerability to these shocks, the production structure must be diversified away from oil and fiscal discipline upheld.

Keywords: *International commodity, price shocks, Output fluctuation, Policy, aggregate output*

INTRODUCTION

Forces driving movements in macroeconomic performances of tropical and contemporary economies have been at the core of macroeconomic debates and have attracted the attention of researchers studying the stochastic nature of macroeconomic dynamics. These movements literary described as volatility or fluctuations represent deviation from the steady state of macroeconomic equilibrium. By extension, volatility refers to a situation of rapid fluctuations in the overall condition of critical indices in the economy measured by real output, output growth rates, price inflation and monetary growth. Notable of all these indices is output measured in levels or in growth rates (Addison, 2002). Whichever measure of macroeconomic volatility, the phenomenon as orchestrated by Olotu, Olele and Iyoko (2010), is highly prevalent in the developing countries, particularly the export-enclave economies with Sub-SAHARAN Africa receiving the worst hit. Among the most volatile are not just small economies but also large ones, many of which are predominantly primary commodity exporters. This is traceable to exogenous shocks from the international prices of primary commodity exports such as oil, sudden stops to capital inflows and abrupt changes in the international terms of trade all of which unleash

mayhem on macroeconomic equilibrium (Ramey G. and Ramey V., 1995; Aizenman and Pinto, 2005). On the other hand, developing countries can also experience domestic shocks generated by self-inflicted policy mistakes (Loayza, Ranciere, Serven and Ventura, 2007). According to Fatas and Mihov (2006), governments often instigate fluctuations in macroeconomic performance by conducting erratic fiscal policy and worse, financing it through similar volatile inflationary monetary policy. The incidence, severity and frequency of sharp changes in government fiscal balances for countries at different income levels suggests that developing countries is bedeviled with volatile fiscal policy. More generally, Raddatz (2007) finds that in low-income countries domestic shocks account for the bulk of fluctuations in GDP. For this group of countries, external shocks linked to terms of trade, foreign aid among others, contribute a significant but small portion of their overall macroeconomic volatility.

Also in line with the above, Giovanni and Levchenko (2006) synthesize that trade openness magnifies the output consequences of terms-of-trade shocks. Thus, countries more open to trade tend to be more volatile. Again, developing countries have weak and sometimes deficient shock absorbing mechanisms in the form of stabilization policies which counters aggregate shocks (Spillipoulos, 2004). And macroeconomic policies, far equilibrating the deviations, often amplify it. So, exogenous shocks translate uninhibited to output volatility. Evidently, for countries relying on export of a single product, a price upturn shifts the supply function upwards generating higher income to owners of factors. Where the government is the major driver of economic progress, the bulk of the rent is assigned to public expenditure programs leading to monetary expansion. This boosts the disposable incomes of economic units thereby beefing up aggregate demand and output soars. With exports concentrated on oil, output becomes vulnerable to the economy's exposure to cataclysmal movements in oil price so that exogenous fluctuations induce deviations from steady-state equilibrium (Barro, 1993). Additionally, besides oil price volatility as a major cause of macroeconomic disturbance, external shocks may also arise from other non-fuel commodity price fluctuation. This effect according to Iyoha (2004) will however vary, depending on the effect of this price on the demand and supply sides of the economy. A rise in the price of an imported commodity raises the cost of production and decreases the output supplied. In contrast, a rise in the price of a major export commodity raises revenues and has a spill-over effect.

Admittedly, in Nigeria, the pattern of economic volatility is complex. At the macroeconomic level the high volatility recorded in real growth rates, price inflation, government revenues, terms of trade and real exchange rate closely reflect the movements of oil prices. As evident in a plethora of studies, for example, by Addison (2002), Nigeria ranked amongst the last five countries with the highest incidence of macroeconomic distortions. Accordingly, between 1975 and 2000, Nigerian broad macroeconomic aggregates were among the most volatile in the developing world, a report which is consistent with Ukwu, Obi and Ukeje (2005) who place the country among the top ten most volatile nations. This illustrates a major paradox in Nigeria. As documented in Iwayemi (1995, cited in Olotu, Olele and Iyoko, 2010), before 1970, output recorded a steady growth of 3.1% annually such that when oil became the centerpiece of the

economy, Nigeria nursed the dream of becoming Africa's economic giant. While the dream lasts, macroeconomic distortions demonized the landscape and spread like wildfire. The empirical connection between macroeconomic volatility and lack of development is undeniable, making the phenomenon a fundamental development concern. As Raddatz (2007) has it, output volatility bequeaths a welfare cost for developing countries. First, volatility entails a direct welfare cost for risk-averse individuals, as well as an indirect one through its adverse effect on income growth and development. Besides disproportionately translating to fiscal consumption volatility (Fatas and Mihov, 2006), it has this negative effect through its links with various forms of uncertainty - economic, political, and policy-related.

Volatility reduces economic growth, particularly in poor underdeveloped countries that are unable to conduct counter cyclical fiscal policies (Aizenman and Pinto, 2005). As noted by Olotu, Iyoko and Olele (2010), the greatest menace to achieving a virile economy has been the persistence of fluctuations in broad macroeconomic aggregates. It is a major constraint to development, making planning more problematic and investment more risky. Thus, if concerted efforts are not made to redress the vulnerability of output to exogenous shocks or policy volatility, Nigeria heads for a doom. To resuscitate the economy and place it on a steady growth path, a virile, consistent macroeconomic policy is necessary. Since policy implications vary depending on the major factors responsible for fluctuations in aggregate output, this analysis will guide policy makers regarding the policy variable to culture and the extent to culture it in order to reduce the menace. This is because, if policy is not vested with ample knowledge of the dosage of the requisite change to be made, it may exacerbate the existing cleavages. Thus, a compact empirical analysis of what precipitates output fluctuation is required. While theory underpins it to exogenous shocks from international price of primary export commodities and sudden stops to capital inflows, the economy's self-inflicted policy mistake is also liable. It is in light of this preoccupation that this study is conducted to examine the extent to which aggregate output is vulnerable to volatility in international commodity prices.

METHOD

Business cycle theories have been developed each stressing a particular factor responsible for cyclical fluctuations in economic activities. The monetary school attributes the cycle to the expansion and contraction of bank credit while the Neo-classical real business cycle theory suggests that fluctuations result from shocks to our ability to produce goods. To the monetarists, changes in monetary expansion are the dominant forces behind the business cycle (Barro, 1993). Another possible explanation is through the application of the Mundell-Fleming Model. The model assumes price as given and then shows what causes fluctuation in income and exchange rate. According to the theory, under floating exchange rates, fiscal policy does not influence aggregate output. Thus, a fiscal expansion only causes the currency to appreciate, reducing net-exports and offsetting the expansionary impact on income. The model as amplified by Dornbusch, Fischer and Strz (2004) contend that monetary policy has similar effect. In a floating exchange regime, a monetary contraction raises the exchange rate, lowers

exports and reduces income. In a fixed exchange regime however, a monetary expansion raises the interest rate, lowers investment and thus lowers output. For countries depending on a single product, a price upturn shifts the supply function upwards generating higher income to owners of factors. If the government is the major driver of economic progress, the bulk of the rent is assigned to public expenditure programs leading to monetary expansion. This monetary expansion boosts the disposable incomes of economic units, which consequently beefs up aggregate demand and hence increase in output (Ramey and Ramey, 1995; Turnovsky and Chittopadhyay, 2003; Spillioopoulos, 2004; Raddatz, 2007). The study adopts a variant of the Sensitivity Analysis of Barro and Sala-i-Martin (1995):

$$Z = g(x_1, x_2, \dots, x_n) \dots\dots\dots (1)$$

Where: Z = Index of Macroeconomic Variability (GDP Growth Rates)
 X_1 = Oil Price
 X_2 = Non-oil Commodity Price
 X_3 = Terms of Trade Shocks
 X_4 = Money Supply
 X_5 = Fiscal Balance
 X_6 = Interest Rate
 X_7 = Inflation Rate

For equation 1 to be amenable to empirical computation, it transforms to:

$$Z_t = \alpha_0 + \alpha_1 x_1 + \dots + \alpha_n x_n + \mu_t \dots\dots\dots (2)$$

Where: α_0 = Intercept term
 $\alpha_1, \dots, \alpha_n$ = Parameters to be estimate

The annual time series data covers 1975-2011, a sample size of 37 years. They were obtained from the Central Bank of Nigeria Statistical Bulletin and the World Bank (2011). External variables that entered the model include oil price, non-oil commodity price and terms of trade shocks while country-specific variables are output growth rates which is used as the index of macroeconomic variability, fiscal balance, money supply and interest rate. Real magnitudes are obtained by using the consumer price index to deflate the external variables to real terms and entering the country's inflation rate in the model to deflate country-specific variables to real terms. Since most economic time series are affined to time so that their mean is time-dependent making them non-stationary, the first step of our analyses is to investigate the existence of unit roots using the Augmented Dickey-Fuller test (Iyoha and Ekanem, 2002) given by:

$$\Delta Z_t = \alpha_0 + \delta Z_{t-1} + \beta_1 \sum_{i=1}^n \Delta Z_{t-i} + \varepsilon_t \dots\dots\dots (3)$$

Where: Δ = First-difference Operator
 δ = Stationarity level

Where unit roots exist, the nuisance variable will be made stationary by entering it into the model according to its order of integration. Again, there is a possibility of long-run

relationship among the variables. In the event that “Z” has an identical order of integration with any of the explanatory variables, we suspect co-integration. We thus run a linear combination of these variables in their level form without the intercept and then test their residual for unit roots. If the residual is integrated as suggested by Gujarati (2004), co-integration is established and the model estimated using the Error Correction Model given by:

$$\Delta Z_t = \alpha_0 + \alpha_1 \Delta X_t + \alpha_2 \Delta X_{2t} + \dots + \alpha_n \Delta X_{nt} + \beta_1 u_{t-1} + \varepsilon_t \dots (4)$$

Where;

$\beta_1 u_{t-1}$ = Error Correction representation

u_{t-1} = Long-run separator of “Z” from the vector of explanatory variables

β_1 = Coefficient measuring the degree of error corrected

This will help to account for the speed of adjustment of the deviation from the long-run equilibrium. But if co-integration is not established, we revert to estimating equation 2.

Residual Normality Test: This tests whether the residuals are normally distributed. The Jarque-Bera statistic is used. The test which follows the Chi-squared distribution is given by:

$$n \left[\frac{s^2}{6} + \frac{(k - 3)^2}{24} \right] = JB$$

Where: **S** = Skewness Coefficient and

K = Coefficient of Kurtosis.

For a normally distributed residual, the value of S and k are 0 and 3. Since the JB computed is expected to be zero with 2 degrees of freedom, if the value is close to zero and/or the P-value reasonably high, the residuals are normally distributed and vice-versa. Prior to the estimation of the empirical model, since results emanating from empirical models are likely to be spurious if the variables are non-stationary and co-integrated, to avoid the nonsense correlation that is likely to arise therein, necessary tests were completed. Following the ADF, unit roots test was run on the levels of the variables and on their 1st, 2nd and 3rd differences and the result displayed tabulated and discussed (Table 1).

RESULT AND DISCUSSION

Table 1: ADF Unit Root Test on the Annual Series

Variable	g^*	oilp	nop	Tot	fb	ms	r	Inf
I ~ (d)	2	1	1	2	1.	1	1	.2

NOTE: ADF Critical Value at 5% is -1.958.

From the table, all the variables are integrated of order one, $1 \sim (1)$ except the dependent variable g^* and an explanatory variable, **ms** which are stationary at their second

differencing respectively. Next we turned to the cointegration property of the non-stationary variables in the model. Then we implemented the Engle-Granger co-integration test by running the linear combination of g^* and ms in their level form without the intercept with result displayed thus:

Table 2 Result of Co-integration Tests for the Residuals

	t-adf	Lag	Critical value
Residual 1	-1.1611	2	-1.952
Residual 2	-0.8032	1	“
Residual 3	-0.4177	0	“

From the table, none of the t-adf exceeds the critical value (-1.952) at the 5% level of significance. Thus, the Engle-Granger co-integration statistics accepts in strong terms, the null hypothesis of zero cointegration. That is to say, the test of long-run relationship performed on a subset of both external and country-specific variables reject the hypothesis of cointegration and so indicating the absence of co-integration. Since there is no long-run relationship between the dependent variable g^* and the explanatory variable ms , we discard the notion of an ECM and the variables were entered into the model according to their respective orders of stationarity. The result is presented in a compact form below:

$$g^* = 0.11 + 3.71oilp + 1.22nop + 1.30tot + 0.61fb + 0.48ms - 0.15r$$

(-3.12) (-0.44) (-5.21) (2.81) (0.33) (1.56)

$$R^2 = 0.69; \quad F(7, 28) = 31.23; \quad DW = 2.15.$$

From the result, the model is good. This is evident in the high R^2 value of 0.69 indicating that approximately 70% of the total variation of the behaviour of GDP growth rates has been explained by all the explanatory variables taken together. Since, the observed value of F (31.23) exceeds its critical value at the 5% level, the F -statistic significantly explains the R^2 . The DW value of 2.15 implies the slight presence of serial correlation in the model. From the JB statistic of 3.0026 and a high P value of 0.57, the results of the Jacque-Bera residual normality test indicates that the residual are normally distributed.

In the result, movement in real output growth rate is driven by both external and country-specific shocks. Among the external shocks to the Nigerian economy, oil price shocks and terms of trade shocks appear the most important. Oil price shock has the expected positive sign with a very robust coefficient of 3.12 implying that a percentage increase in oil price induces an average of 31 percent increase in output growth rate and vice-versa. Since oil price hike boosts the disposable incomes of its owners, which beefs up aggregate demand in the system, sporadic fluctuations in the variable releases untold deviations in the economy's output growth rate. The significance of terms of trade shock undoubtedly emanates from the economy's heavy reliance on primary export. The positive sign and large size of the variable shows the vulnerability of output to a rise in the variable. Holding all other factors constant, a percentage increase in terms of trade will induce about 13 percent increase in output growth rate and vice-versa. Non-oil commodity

price variable is not statistically different from zero. Of the country-specific shocks employed in the model, only fiscal balance proves significant as a major predictor of the economy's level of output variability. The significance of the fiscal balance undoubtedly emanates from the economy's heavy reliance on oil revenue which is monotonically determined by the international price of oil. The positive sign and robust size of the fiscal balance show how frequent changes in the variable unleash deviations on the steady growth rate. Holding all other factors constant, a unit increase in fiscal balance will induce an increase in output growth rate by 2.81 units and vice-versa. Any fiscal expansion raises the disposable incomes of economic agents and this increases aggregate demand. To meet the increased demand, business units expand production leading to increased output through the multiplier effect. The robust result of fiscal balance is therefore not out of place. Thus, in oil-producing economies, output is highly vulnerable to volatility in fiscal positions which in turn is vulnerable to volatility of international commodity prices. The surprising result is the relationship between movements in the financial variables (money supply and interest rates) and variations in output growth rates. Although, both variables possess their expected positive and negative signs for money supply and interest rate respectively, they are not significant. These observations do not only go against theory but are also inconsistent with existing empirical studies both in Nigeria and elsewhere.

CONCLUSION

The study is carried out to ascertain the vulnerability of aggregate output in Nigeria to volatility in international commodity prices using a variant of the Sensitivity Analysis. Prior to the estimation of the empirical model, a number of tests were completed - stationarity and long-run relationship. Following the Augmented Dickey-Fuller, unit roots test was run on the levels of the variables and for their 1st, 2nd and 3rd differences and we found the existence of unit roots in all the variables which were made stationary after differencing. The Engle-Granger co-integration statistics accepts the null hypothesis of zero cointegration at the 5% level of significance and so, the model was estimated with the variables entered according to their respective orders of stationarity. The result of the model indicates that movement in output growth is driven by both external and country-specific shocks. Among the external shocks to the Nigerian economy, oil price shocks and terms of trade shocks are the most important. From the country-specific shocks employed in the model, only fiscal balance proves significant as a major predictor of the economy's level of output variability. The surprising result is that movements in the financial variables (money supply and interest rates) are not statistically different from zero. These observations do not only go against theory but are also inconsistent with existing empirical studies both in Nigeria and elsewhere. Since oil price is beyond the manipulation of the authority, the economy should introduce "shock absorbers" to cushion off the perilous effects of exogenous shocks while diversifying the production structure away from oil. In the meantime, the authority should abolish the operational fiscal policy riddled with inconsistency and adopt a tighter fiscal discipline.

REFERENCES

- Addison, N.** (2002). *Nigeria: Policy Options for Growth and Stability in a Challenging Environment*. World Bank Publication.
- Aizenman, J. and Pinto, B.** (2005). *Managing Economic Volatility and Crises*. Cambridge, United Kingdom: Cambridge University Press.
- Barro, R.** (1993). *Macroeconomics*. New York: Willey. 4th Edition.
- CBN.** Statistical Bulletin and Statements of Accounts. Various years.
- Dornbusch R., Fischer S. and Startz R.** (2004). *Macroeconomics* (9th Edition). Delhi: McGraw-Hill Inc.
- Fatas, A. and Mihov, I.** (2006). *Policy Volatility, Institutions and Economic Growth*. Singapore and Fontainebleau, France: INSEAD.
- Giovanni, J. and Levchenko, A.** (2006). *Openness, Volatility and the Risk Content of Exports*. Washington, D.C.: International Monetary Fund
- Gujarati, D. N.** (2004). *Basic Econometrics*. New York. McGraw-Hill.
- Iwayemi, A.** (1995). *Oil and the Macroeconomy: A Perspective on Recent Economic Performance*. Ibadan: NCEMA Publication.
- Iyoha, M. A. and Ekanem, T. O.** (2002). *Introduction to Econometrics*. Benin City: March Publishers.
- Iyoha, M. A.** (2004) *Macroeconomics: Theory and Policy* (Revised Edition). Benin City: Mindex Publishing
- Loayza N. V., Ranciere R., Serven U. and Ventura J.** (2007). Macroeconomic Volatility and Welfare in Developing Countries: An Introduction. *The World Bank Economic Review*, 21 (3), 343-357.
- Olotu M. E., Olele H. E. and Iyoko E.** (2010). Sources of Macroeconomic Instability in Nigeria. *International Journal of Investment and Finance*, 3 (1&2), 170-178
- Raddatz, C.** (2007). Are External Shocks Responsible for the Instability of Output in Low-Income Countries? *Journal of Development Economics*, 84 (1), 155-87.
- Ramey, G. and Ramey, V.** (1995). Cross Country Evidence on the Link between Volatility and Growth. *American Economic Review*, 85 (5), 1138-51.
- Spilliopoulos, L.** (2004). *What Determines Macroeconomic Volatility: A Panel Data Study*. Chippendale. NSW: University of Sydney.
- Turnovsky, S. and Chittopadyay, P.** (2003). Volatility and Growth in Developing Economies: Some Numerical Results and Empirical Evidence. *Journal of International Economics*, 59, 231-48
- Ukwu I., Obi U. and Ukeje S.** (2005). *Policy Option for Managing Macroeconomic Volatility in Nigeria*. Enugu. AIAE.
- World Bank** (2011). World Development Indicators. Washington D. C.: World Bank