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Food Security Implications of Changes in Food Commodity Prices in Nigeria

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Abstract
Achieving food security represents a top policy priority around the world given that the levels of hunger and malnutrition have remained disturbingly high. Recent years have seen the nutritional status and food security of millions of people being further undermined by high and volatile food prices.Large and unexpected changes in food prices represent an important risk factor and constitute serious threat to food security, especially in developing countries like Nigeria. The study therefore examined the effects of changes in food prices on food security in Nigeria using monthly and annual time series data over the period of 2000 to 2020.The study used Coefficient of Variation (CV) to estimate changes in food prices (food price volatility) while the Autoregressive Distributed lag(ARDL)Model was employed to determine the response of national food security to changes in food prices. The results show that theprices of most food items witnessed a forward leap between the periods 2000-2006 and 2007-2012with the price of rice almost experiencing a threefold rise. In general, changes or volatility in food prices have been decreasing, with the highest volatility of about 6% recorded in the first subperiod (2000-2006)- a value higher than that of the overall period (4.6% in 2000-2020). Food price volatility was shown to have significant effect on per capita food supply variability and average energy supply dietary adequacy, both of which were used as measures of food security in the study.The significant impact of food price volatility on per capita food supply variability suggests the need for government to provide agricultural price support and inventory management strategies to farmers, particularly the smallholders, who account for a large percentage of agricultural production in Nigeria. Government can also adopt a short term policy mix of establishing regionally coordinated food reserves while strengthening social protection measures and coverage in order to secure national food security.
Key Words: *food security, food prices, price changes, price support*

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I. Introduction

Achieving food securityrepresents a toppolicy priority around the world given that the levels of hunger and malnutrition have remained disturbingly high. For instance, in 2021, about 720-811 million people experienced hunger while the prevalence of undernourishment,that remained virtually unchanged between 2014 and 2019, increased from 8.4% in 2019to 9.9 % in 2020 (FAO,2021). Of the total number of people that faced hunger in 2020, 57 million were found in Asia, 46 million in Africa and 14 million people in Latin America and the Caribbean. Also, about 1.9 million people, experience moderate to severe food insecurity globally (Roser and Hannah,2019). Like in most developing countries, aquick snapshot at the available statistics on food security in Nigeria, reveals disturbing results. Based onFAO et al(2020) study conducted in West Africa, Nigeria has about 5 million people in food crisis which represent the highest value recorded for the 15 countries considered in the region. Of the 5million people, Borno, Adamawa and Yobe states in the North East account for about 29 %. A similar assessment by FAO and UN (2020) shows that out of the over 135 million people in 55 countries and regions facing acute food insecurity in 2019, Africa represents about 73 million of the population, 5 million of which are from Northern Nigeria. The situation is however extremely bad in Borno where over 80 percent of the population are categorized as being in an Emergency CH phase 4 situation. The outbreak of the Covid-19 pandemic has also exacerbated the existing challenges with the number of people needing humanitarian assistance increasing from about 7.1 million people in 2019 to 7.9 million in 2020 (Reliefweb, 2020).

The already worrisome state of food insecurity in the country is further exacerbated by high and volatile food prices. NBS (2020) report reveals that food inflation increased from 14.5% in January 2020 to about 17.4% in October 2020. The report alsoshows that food price index increased from 95.8 points in 2009 to 109.9 points in 2010, averaged 148.9 points (10%) between 2011 to 2015 and up by 15% in 2016 (base period 2009=100). The most remarkable increase in food prices was recorded in 2017 where composite food price index rose by almost 20% over that of the year 2016. However, 2018 witnessed significant improvement in CPI as it decreased by 14%, a change which persisted till 2019. More recently, the index increased by 20.57% in January 2021 compared to an increase of 19.56 % in December, 2020 (NBS, 2021). Food prices have increased continuously, although price volatility has been less intense in recent years. Apparently, food price has remained high without corresponding increase in disposable personal income (the growth of which has stagnated at less than 1% since 2009) (NBS, 2020) or adequate protective policies or subsidies to shield the producers.

Instability in food prices is an important risk factor and constitute serious threat to food security, particularly in developing countries. Evidence abound that food price volatility in the last decade has greatly increased the number of hungry people while undermining food security and nutritional status (HLPE, 2011). According to Global Panel (2016), the danger of extreme price events has different implications for producers and consumers. While consumers are more affected by price spikes which are sudden, large and temporary changes in prices affects producers. High food prices affect the consumption pattern of households, especially the poor and vulnerable ones who spend up to 80% of their income on food and they therefore bear the burden of food price increases the most (Juarz-Toress, 2015). They primarily respond to sudden negative price or income shocks by cutting back sharply their food consumption spending (Capuno et al., 2013). Although producers benefit from high prices by taking advantage of the associated profit, which eventually improves future physical availability, significant, frequent and unexpected changes in food prices according to Global Panel (2016), put producers at risk of making investment and production decisions because of uncertainty surrounding future prices.The presence of high risk constitutes a disincentive to farmers which leads to a reduction in food production as producers tend to move to other investments in non-agricultural sector with lower risks (Haile et al,2013). With little or no changes in supply in response to high and volatile food prices, food supply may remain unchanged or tight alongside the welfare gains for net producers (Magrini et al 2016). Since producers are more affected by sudden and unexpected changes in prices, there is a need to understand how these changes affect food production and stability, both of which are key dimensions of food security. This study therefore examined the effect of food price volatility on food security through the producers' lens.

Effects of Volatile and Extreme Food Prices

Food price volatility, whose manifestation is demonstrated in the type of price hikes experienced in poor countries, is generating considerable anxiety in these countries where storage capacity and price integration across different regions are limited (Arezki et al, 2016). A reconnaissance of literature reveal scores of the associated consequences of food price volatility. Food price volatility arising from increase in international food prices affects the macroeconomic policy actions of countries around the world, particularly food import dependent countries, leading to high lending rates, inflationary pressures and volatile exchange rate (Fasanya and Olawepo, 2018).

Although the population of the world poor has decreased significantly, more than 40 % of the Sub-Saharan population still live in extreme poverty. Existing indices in Nigeria, for example reveal high and disturbing levels of extreme poverty. Hence, hikes in food prices have serious consequences for people in this category because the increases worsen their precarious economic situation by lowering their purchasing power and food security (HLPE, 2011). Repeated episodes of high food volatility and prices and are major threats to food security, particularly in developing countries (World Bank, 2012). Amolegbe et al (2021), in their study of the effect of price volatility on food security in Nigeria found that upward volatility in the price of imported rice have negative implications for food security and the impact on household food share was higher for poor households than the rich ones. Okeke-Agulu and Aojeifo (2019) also reported similar result in which case food price volatility significantly reduced food security of households in Jos-North Local government area of Plateau state, Nigeria.

As earlier mentioned food price volatility has different implications for producers and consumers. For net consumers, high and sustained food prices negatively impact their consumption pattern given that food share in the total consumption basket is substantively high. This may therefore result in decreased caloric intake and dietary diversity which ultimately intensifies household food insecurity. Akerele (2013) showed that about 3.99 million Nigerians transitioned into hunger and calorific undernutrition due to spikes in food prices. Ikuemonisan et al (2019) pointed out that due to high food inflation, households had to forgo an average of 12% of their food consumption and 13% of their transportation expenditure to ensure continued household food stability. High food prices is of serious concern particularly for already malnourished preschool age children as the impact on them is irreversible even after periods of price decline or stabilization (World Bank, 2012). For producers, although high prices may seem favourable initially, but when coupled with increased volatility, supply may reduce even in the face of remarkable price incentives due to the associated production risks (Baliè et al, 2016). With dawdling and minimal response to high and volatile prices, changes in food supply along with the welfare gains of producers may remain inappreciable (Magrini et al, 2016).

II. Methodology

The study investigated the effects of changes in food prices on food security in Nigeria using both monthly and annual data for the period 2000-2020. The time series data were obtained from reliable secondary sources which include FAOSTAT, NBS, World Bank, IMF, FEWSNET, among others. The series considered in the study include GDP growth rate, population growth rate, average dietary energy supply adequacy, per capita food supply variability (Kcal per capita per day),composite food and consumer price indexes, lending rate, and crude oil price (Bonny light). Others include agriculture budget share, defence budget, food price index among others. Data selected in the study were based on literature review as well as on data availability for the period 2000-2020.

Method of Data Analysis

The study employed both descriptive and econometric techniques. Descriptive analysis was used to describe the state of food security and movements in food prices in Nigeria. Means and standard deviations were used to compute the Coefficient of Variation used in estimating food price volatility. Econometric analysis, on the other hand, was used establish the effect of food price volatility on food security. The analytical techniques required for the econometric analysis include Diagnostic tests analysis (Augmented Dickey Fuller Test, ARDL Bounds test), and Autoregressive Distributed lag(ARDL) Model**.**

Coefficient of Variation

The coefficient of variation is expressed as the ratio of the standard deviation of a given resource or variable to its mean (Pauw, 2003).

$$C = \frac{\sqrt{V}}{\mu} \qquad (1)$$

Where $\sqrt{V}$is the standard deviation and μ is the mean

By extension, the coefficient of variation was used to derive food price volatility calculated as the ratio of the standard deviation of monthly food prices to the mean of the prices over the period 2000-2020.

Unit Root

The unit root test was conducted to test for stationarity of the time series data. The study employed theAugmented Dickey-Fuller (ADF) to establish whether there exists unit root in the time series data considered. The test equation is generally represented as (Dickey and Fuller,1981):

$$\Delta H_t = \sigma_0 + \sigma_1 t + \rho H_{t-1} + \sum_{i=1}^{l} \gamma_i H_{t-1} + \mu_t \qquad (2)$$

Where Δ represents the first difference operator, H is time series data, σ_0 is the coefficient and $\sigma_1$is the coefficient of the trend series, ρ is the lagged order of the autoregressive process, $H_{t-1}$is the series data in time t-1 and μ is the error term. A series that is stationary without any differencing is depicted as I(0) or integrated of order zero while those that are stationary at first difference are designated as I(1). In sum, the number of differencing done to make a series stationary is represented by the value in parenthesis.

Cointegration Test

There is a need to test time series data for cointegrationas co-integrated variables never move apart but are attracted to their long run relationship (Koop,2000). Following that the results from the unit root test show that the series are of mixed order integration (Table 3), the study therefore used the Autoregressive Distribution Lag Model (ARDL) Bounds test to establish whether there exists long run relationship between the time series data. The Bounds test for cointegration is carried out under the following assumptions:

$$H_0: \gamma_1 = \gamma_2 = \gamma_3 = 0$$
$$H_1: \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq 0$$

The null hypothesis (H_0) assumes that there is no cointegration and when rejected, the alternate (H_1) of cointegration holds. The decision to reject or accept the null hypothesis is made by comparing the F-statistics with the critical values of the estimated model. The null hypothesis of no cointegration is accepted if the F-statistics is less than both the upper bound I(1) and Lower bound I(0) values.

Autoregressive Distribution Lag (ARDL) Model

The ARDL, an Ordinary Least Square based model, is used for the analysis of time series variables which are both non-stationary and integrated of different orders (Pesaran et al, 1999). The ARDL is generally specified as follows:

$$Y_i = \alpha + \beta X_i + \varphi V_i + \epsilon_t \quad (3)$$

Modifying equation (3) to show the short run and long run components of the ARDL model gives:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta Y_{t-1} + \sum_{i=1}^{n} \tau_i \Delta X_{t-1} + \sum_{i=1}^{n} \delta_i \Delta V_{t-1} + \gamma_1 Y_{t-1} + \gamma_2 X_{t-1} + \gamma_3 V_{t-1} + \epsilon_t \quad (4)$$

Where Δ represents the first difference operator, Y_t and X_t and V_t are the explanatory variables. β_i, τ, and β_i are coefficients that measure short run dynamics while γ_1, γ_2 and γ_3 are the log run components of the ARDL model. α_0 is the drift component while ϵ_t is the error term which is independently and normally distributed with a constant variance.

By extension, the study specified two models for two food security indicators: per capita food supply variability (Kcal per capita per day) and average dietary energy supply adequacy (%). The study selected the per capita food supply variability and average dietary energy supply adequacy because they are indicators for food availability and food stability dimensions, respectively, both of which address the supply side of food security likely to be affected by food price volatility. These indicators represent the dimensions of food security which are likely to be influenced by investments made by producers.

Thus, the ARDL specifications for the food security models are given as follows:

$$\Delta Y_1 = \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta Y_{t-1} + \sum_{i=1}^{n} \tau_i \Delta X_{t-1} + \sum_{i=1}^{n} \delta_i \Delta V_{t-1} + \epsilon_t \quad (5)$$

$$\Delta Y_2 = \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta Y_{t-1} + \sum_{i=1}^{n} \tau_i \Delta X_{t-1} + \sum_{i=1}^{n} \delta_i \Delta V_{t-1} + \epsilon_t \quad (6)$$

Y_1 and Y_2 are per capita food supply variability (Kcal per capita per day) and average dietary energy supply adequacy(%), respectively. X is the vector of explanatory variables including COEV, LNAGRIC, POPGR, DBJ, LNWFS, GDPGR, LNEXR, NUN and FPI. COEV is the coefficient of variation which was used to measure changes or volatility in food prices. The definitions of the other variables are given in Table 1. It is important to note that annual data were used for the variables included in the regression because monthly data on food security variables are not available in Nigeria. However, the monthly data for food price index were used to calculate annual volatility in food prices using the coefficient of variation method.

Table 1: Definition and Measurement of Variables

Variable	Definition	Measurement
COEV	Coefficient of variation	Ratio of the standard deviation of monthly food prices to the mean of the prices over the period 2000-2020
LNAGRIC	Agricultural budget share	Percent
POPGR	Population growth	Percent
DBJ	Defence Budget	Billion US Dollars
LNWFS	World Total Food Supply	Kcal/capita/day
GDPGR	GDP Growth	Percent
LNEXR	Exchange rate	Percent
FPI	Food Price Index	Index points

III. Results and Discussion

This section focuses on the trend of food price volatility in Nigeria as well as its effect on national food security. Before the effect of food price volatility can be established, a number of preliminary tests were conducted. These include unit root test and cointegration test.

Nature and Trend of Changes in Food Prices in Nigeria

To measure the extent of variations in food prices, the study estimated the coefficient of volatility of food price index and selected crops over the period January 2000 to December 2020. Findings reveal that price volatility was lowest for Sorghum (0.151), followed by Maize (0.187) and Rice (0.199) with the highest volatility noticed in Millet (0.461). In all the sub periods, Millet maintained the highest price volatility, reaching an all-time high of 0.656 in the period 2007-2012. As documented in the report by AVISA (2021), apart from the abandonment of millet crop for other popular grains such as rice, maize, soybean and wheat, the extremely high volatility in Millet prices, particularly between 2007-2012, was probably due to inadequate access of farmers to improved seeds and rising insecurity in the Northern part of Nigeria, particularly in Borno State which is a major millet producing state. As a response, AVISA (2021) revealed that several campaigns have been put in place to increase millet production in Nigeria. These include prioritizing millet as a choice crop in the achievement of food and nutrition security, especially in achieving the SDG Goals 2,3,12 and 13, promoting iron-biofortified pear millet, enlightenment and sensitization of farmers, among others. Despite all the several interventions for the development and adoption of high yielding varieties of millet, its production, as revealed by Statista (2021), has not resumed its peak value of 9,064 metric tonnes in 2008, only averaging about 1,593 metric tonnesbetween 2011-2021. Therefore, the variations in production volumes accounts to a reasonable extent for the high volatility of millet prices.

In general, food price volatility has been decreasing, with the highest volatility of about 6% recorded in the first sub period, a value higher than that of the overall period (4.6%). This results suggests that food price volatility in Nigeria has been generally weak. This finding sits well with that of Minot (2014) who refuted the widely held claim that food prices have become more volatile in Sub-Saharan Africa ever since the 2007/2008 food crisis. Going by the forgone, high level of food prices rather than food price volatility may represent a more immediate problem in Nigeria.

Table 2: Price volatility of selected food commodities, 2000-2020

	Coefficient of Variation			
	2000-2006[a]	2007-2012	2013-2020	2000-2020
Maize	0.148[b]	0.132	0.249	0.187
Millet	0.466	0.656	0.311	0.461
Rice	0.118[c]	0.189	0.247	0.199
Sorghum	0.201[c]	0.092	0.170	0.151
Food Price Index	0.059	0.044	0.038	0.046

[a]-price data for computing CV only available from year 2002 for all food commodities; [b and c]- commodity prices not available in years 2003 and 2004, respectively
Source: Author's calculation from CBN data

Unit Root Test

The unit root test, which gives information about the degree of integration of the annual time series variables, was conducted using the Augmented Dickey Fuller test. The results are presented in Table 3. Except PCFS, DBJ and COEV, which were stationary at their levels, I (0), other variables were observed to be stationary at first difference, I (1). Thus, the null hypothesis of no unit root was only accepted for PCFS, DBJ and COEV while it was rejected for all the other variables.

Table 3: Test for stationarity for the Effect of Food Price Volatility on Food Security

Variable	**Level**		**First Difference**		**Order of integration**
	Trend	Trend & Intercept	Trend	Trend& Intercept	
PCFS (Y_1)	-3.1127**	-3.3557*	-3.9519***	-3.7730**	I(0)
MDER	0.6561	-0.1850	-3.4615**	-4.5707***	I(1)
EXR	1.6748	-0.2630	-2.3443	-4.1548**	I(1)
POP	5.2409	-0.82011	-2.4356	-4.9830***	I(1)
COEV	-4.2495***	-4.8776***	-9.3354***	-9.3731***	I(0)
FODPR	-0.3016	-2.4875	-5.4763***	-5.5071**	I(1)
DBJ	-1.7079	1.7054	4.0201***	-3.8065**	I(0)
COIL	-1.6346	-0.9116	-3.0184	-3.9741**	I(1)
GDPG	-3.0021*	-3.5615*	-4.6615***	-3.6073*	1(1)
WFS	-0.1567	-1.5055	-3.4978**	-2.5698	1(1)
NUN	-1.1334	-2.5741	-5.6893***	-4.6160**	1(1)

ARDL Bounds Cointegration Test

Since the results from the unit root test shows that the variables to be included in the analysis have mixed order of integration (i.e I(0) and I(1)), the appropriate technique to use to test for cointegrationis the Autoregressive Distribution Lag Model (ARDL) Bounds test (Shrestha et al, 2018). Table 4shows the co-integration test results for the two models considered in the study.. The F-statistics for Y1 and Y_2 (1.074 and 1.764, respectively) were shown to be lower than both the Upper and lower bound critical values at 1%,5% and 10%. Therefore, the null hypothesis of no integration was accepted for both models. In other words, the two models do not have evidence of long run relationship. Hence the study considered short run ARDL to estimate the effect of food price volatility on food security.

Table 4: ARDL Bounds Test of Cointegration

		PCFE (Y_1)	**AEDA(Y_2)**
F-Statistics		1.0740	1.76425
Critical value bounds			
Lower Bound *I*(0)	10%	2.38	1.75
	5%	2.69	2.04
	2.5%	2.98	2.32
	1%	3.31	2.66
Upper Bound *I*(1)	10%	3.45	2.87
	5%	3.83	3.24
	2.5%	4.16	3.59
	1%	4.63	4.05

The Effect of Food Price Volatility onPer Capita Food Supply variability

The ARDL short run model was analyzed to show the effect of food price volatility on per capita food supply variability and average dietary supply adequacy, both of which are measures of food security adopted in the study. Per capita food supply variability (PCFS) is an important indicator of the food stability dimension of food security. Table 5 presents the effect of food price volatility (COEV) on PCFS. In addition to COEV, the study also considered other explanatory variables these are PCFS, LNEXR, LOGAGRIC, GDPGR, DBJ, LNWFS, LNLENDING, and FPI. Of all the seven (7) variables, only three (3) were significant. It should be noted that lagged values of the variables were included in the model as this is a necessary condition to estimate an ARDL model. Therefore, the discussion of the result is with respect to the previous year's value for all the variables used in the model. Results in Table 5 shows that PCFS in the previous year significantly increase PCFS in the current year. Following historical precedence, past periods of supply variation may be an indication for more volatility (high or low) in the subsequent periods. Although it may not indicate a major volatility spike, understanding historical record of variabilities can help to predict future pattern of fluctuation in prices (Robinson,2021)

Food price volatility was shown to have positive and significant effect ($p<0.01$) on PCFS. As earlier pointed out, uncertainty about future prices puts producers at risk of making production and investment decisions. This is because high price volatility represents large and unexpected changes in price occurring at a rate faster than what producers can adjust to, thereby resulting into greater potential for losses (Pangaribowo et al, 2013). High prices coupled with high volatility increase production risk which tend to lower supply even in the face of high price incentives (Balie et al,2016). Thus, increase in per capita food variability has serious implications for constant and all year round supply of food, an important precondition for the food stability dimension of food security. By extension, increase in food price volatility reduces food security and clear evidence on this association abounds in literature(Balie et al,2016Amolegbe et al, 2021; Kahlkhuhk et al, 2016; Akerele,2013; Ikuemonisan et al, 2019).

A percent increase in the share of agriculture in Nigeria's total budget reduces the likelihood of per capita food supply variability by about 73%. This finding is in concordance with the result of Osuji et al (2021) who established a positive relationship between government spending on agriculture and food security. Increase in the agricultural budget share will spur huge investment necessary to catalyze transformative growth in the sector. For instance, a policy option which focuses on fixing and guaranteeing producer prices will protect and encourage farmers to produce even in the event of wide and unexpected variations in food prices. Result from Table 5 also shows that a unit change in food price index reduces food supply variability by 0.16%. High food prices benefit producers as they take advantage of the associated profit which eventually improves future physical availability but the effect on supply may be muted if the high prices are accompanied by price volatility.

Table 5: Autoregressive Distribution lag model Estimates for PCFS

Variable	Coefficient	Standard Error	Probability
PCFS(-1)	1.0472*	0.5700	0.0994
COEV(-1)	0.5403**	0.2313	0.0443
LNEXR DBJ(-1)	0.5198	0.7421	0.5013
LOGAGRIC(-1)	-0.7298*	0.3823	0.0886
GDPGR(-1)	0.7167	0.4225	0.1241
LNLENDING(-1)	2.3988	1.8025	0.2160
FPI(-1)	-0.0161*	0.0076	0.0627
Constant	0.1680	0.1110	0.1643
R-squared	0.5209	Mean dependent var	-0.0436
Adjusted R-squared	0.1484	S.D. dependent var	0.2349
S.E. of regression	0.2168	Akaike info criterion	0.0851
Sum squared resid	0.4229	Schwarz criterion	0.4772
Log likelihood	7.2766	Hannan-Quinn criterion	0.1241
F-statistic	1.3982	Durbin-Watson stat	2.4365
Prob(F-statistic)	0.3128		

Note- ***, ** and* represent the significance level at 1%, 5% and 10%, respectively

The Effect of Food Price Volatility on Average Energy Supply Dietary Adequacy

The Average Energy Dietary Adequacy is an indicator of food availability dimension of food security which is estimated at the individual level to assess the nutrient adequacy intake of a given population. The factors influencing the average energy supply adequacy (AEDA) are presented in Table 6. Values of COEV, GDP, LNAGRIC, FPI, DBJ and WFS in the previous year were found to have significant effects on the AEDA in the same year.

COEV has a negative and significant effect on AEDA. This implies that as food price volatility increases, the probability that the nutrient intake of an individual will be equal to the recommended nutrient consumption for his or her age and sex decreases. With the supply of food not growing in the face of changes in prices and the accompanying increase in food prices, individuals, particularly the already poor and vulnerable ones, may change their consumption pattern given the substantively high share of food in their total consumption basket. This may therefore result in decreased caloric intake and dietary diversity which ultimately intensifies household food insecurity. This result is in line with those of Akerele(2013) and Ikuemonisan et al(2019) who found out that due to high food prices, a high percentage of Nigerians cut down their food consumption while others transitioned into hunger, and calorific undernutrition.

A unit change in GDP reduced AERD by 0.6%. The observed relationship between GDP and AERD and hence food security, deviate from that of Swietlik (2018) who found out that higher levels of GDP were associated with higher levels of food security and the largest increase in food security was reported in countries with the fastest growing GDP. The reverse trend observed for Nigeria is not surprising given that the budget share of agriculture is not only below the acceptable minimum based on CAADP and Maputo declaration recommendations, but has been ridiculously low and stagnated at less than 2% in the last one decade. Thus, increase in GDP may not necessarily reflect an improvement in food security for countries like Nigeria. A unit increase in defence budget or military spending results into 2.8% decrease in average dietary energy adequacy. An increase in defence budget or military spending suggest spiralling level of insecurity. Nigeria presently is facing multiple challenges of insecurity and this includes Boko haram insurgency, banditry, crop/livestock farmers conflict, kidnapping, among others with people resident in the rural areas, particularly in Northern Nigeria, being the hardest hit. Agricultural production and investment can only thrive in a peaceful and conducive environment. Continued threat to life and properties and actual killings negatively affect agricultural production and investments. Under conditions of insecurity, farming activities are not only hampered but domestic production is stifled with farming communities being abandoned and access to regional markets blocked (Eigege and Cooke,2016). This, among other factors, explains the downward trend in total food supply and the rising food prices being experienced in the country. Rising food prices resulting from security challenges have serious implications for AEDA. Results from the Table 6 also reveal that FPI and WFS to have positive and significant effect on AEDA.

Table 6: Autoregressive Distribution lag model Estimates for AEDA

Variable	Coefficient	Standard Error	Probability
AEDA(-1)	0.1697	0.2674	0.5457
COEV(-1)	-0.0020*	0.0009	0.0583
GDP (-1)	-0.0055*	0.0026	0.0724
LOGAGRIC(-1)	0.0003	0.0002	0.2451
FPI(-1)	0.0163**	0.0068	0.0474
DBJ(-1)	-0.0028*	0.0014	0.0935
CRD (-1)	0.0000	0.0000	0.4892
WFS(-1)	0.0001*	0.0001	0.0669
TOTP(-1)	-0.0407	0.0564	0.4945
Constant	-0.0024	0.0013	0.1038
R-squared	0.7120	Mean dependent var	0.0003
Adjusted R-squared	0.3417	S.D. dependent var	0.0011
S.E. of regression	0.0009	Akaike info criterion	-10.8954
Sum squared resid	0.0000	Schwarz criterion	-10.4053
Log likelihood	102.6111	Hannan-Quinn criter.	-10.8467
F-statistic	1.9228	Durbin-Watson stat	2.4863
Prob(F-statistic)	0.2004		

Note- ***, ** and* represent the significance level at 1%, 5% and 10%, respectively

Diagnostic Statistics

After estimating the ARDL model for PCFS and AEDA, several diagnostic tests were conducted to ensure the validity of the model's assumptions earlier stated. Results from Table 7 shows that the PCFS and AEDA models have desired econometric properties. The Breusch Pagan LM test for serial correlation shows the absence of serial correlation given that the F-statistics for PCFE and AEDA models, 2.9146 and 1.4748, respectively were not significant at 5%. The diagnostic test for heteroscedasticity for both models accepts the null hypothesis of constant variance of the error term. The models also passed the normality test as the Jarquebera test for normality revealed that the residuals of the PCFE and AEDA models are normally distributed.

Table 7: Diagnostic tests results for PCFE and AEDA models

Test		PCFE	AEDA
Serial Correlation (Breusch-Godfrey LM Test)	F-statistic	2.9146	1.4748
	Prob. F(1,8)	0.1262	0.2702
	Obs*R-squared	4.5396	3.3541
	Prob. Chi-Square(1)	0.0331	0.0670
Heteroskedasticity (GlejserTest)	F-statistic	0.3408	2.4599
	Prob.F(7,10)	0.9151	0.1242
	Obs*R-squared	3.5623	12.9162
	Prob. Chi-Square(7)	0.8286	0.1664
	Scaled explained SS	1.9705	3.5976
	Prob. Chi-Square(7)	0.9615	0.9359
Normality	JarqueBera	0.6217	0.4856
	Probability	0.7328	0.7844

Stability Test

The plots of the cumulative sum (CUSUM) obtained from the recursive estimation of the PCFS and AEDA models (Figures 1 and 2) show that the coefficients of the models are stable over the period 2000-2020 as their values lie within the critical bounds of 5% confidence interval (CI).

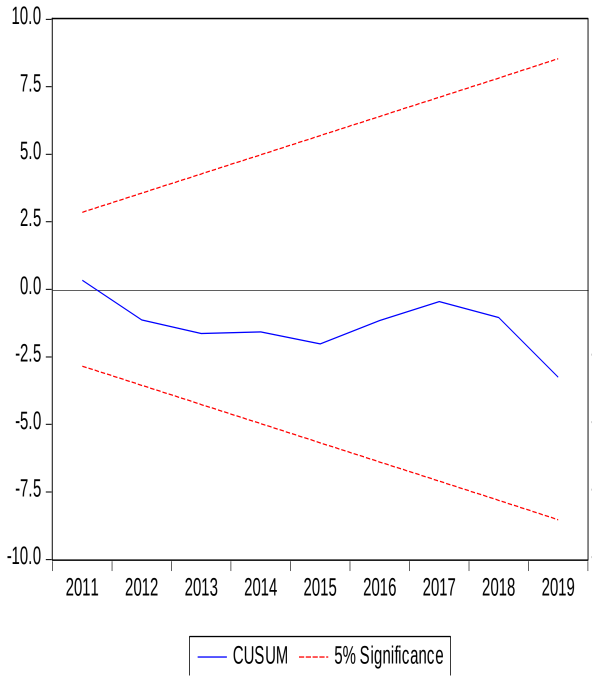

Figure 1: Cumulative Sum Test for PCFS

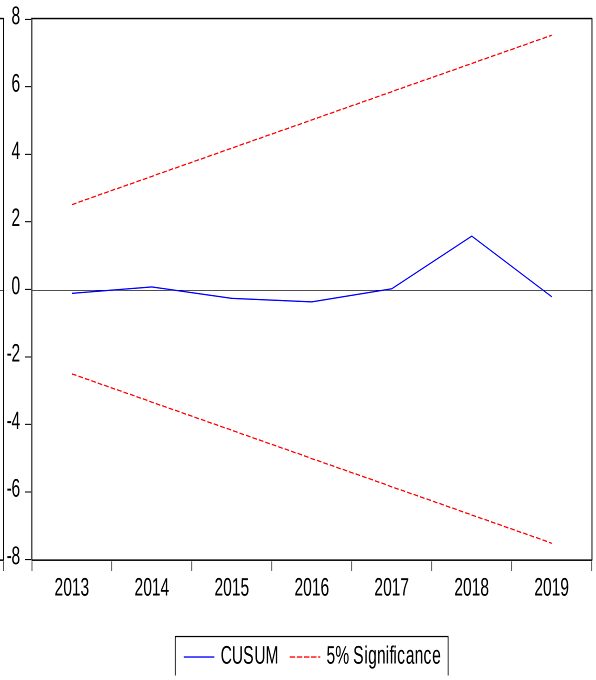

Figure 2: Cumulative Sum Test for AEDA

IV. Conclusion and Recommendations

Fluctuations in food prices represent an important risk factor and constitute serious threat to food security, particularly in developing countries like Nigeria. To this end, the study examined the relationship between changes in food prices and food security. The estimation of coefficient of volatility revealed that the prices of most food items witnessed a forward leap between the periods 2000-2006 and 2007-2012with the price of rice almost experiencing a threefold rise. In general, changes in food prices have been decreasing, with the highest volatility of about 6% recorded in the first subperiod (2000-2006), a value higher than that of the overall period (4.6% in 2000-2020). In addition, volatility in food prices volatility was shown to have significant effect on per capita food supply variability and average energy supply dietary adequacy, both of which were used as indicators of food security in the study.The significant impact of changes in food prices on per capita food supply variability suggests the need for government to provide agricultural price support and inventory management strategies to farmers, particularly the smallholders, who account for a large percentage of agricultural production in Nigeria. Government can also adopt a short term policy mix of establishing regionally coordinated food reserves whilestrengthening social protection measures and coverage in order to secure national food security.

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