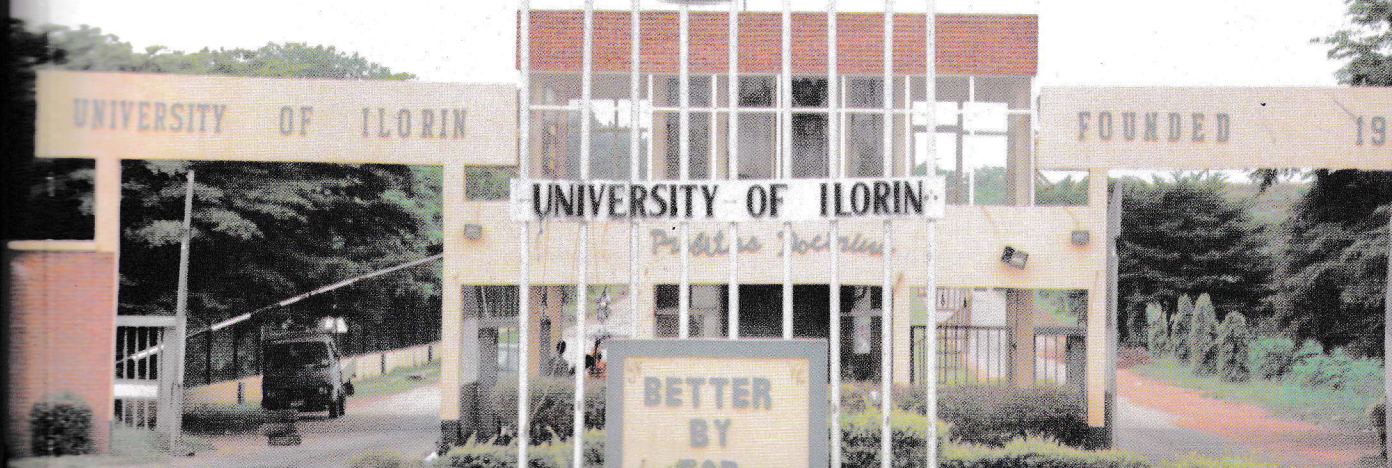
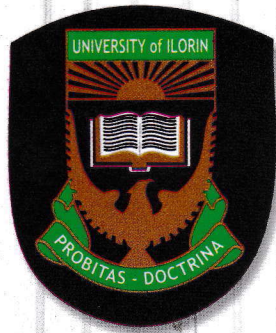




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Abstract

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ASSESSING VOLATILITY IN STAPLE CROPS PRICES IN THE PRE- AND POST-LIBERALIZATION ERA IN NIGERIA

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Abstract

Agricultural liberalization in Nigeria saw to the abolition of commodity boards with the government also withdrawing from the markets whilst allowing for market forces to set prices. One phenomenon that has however persisted over the years is volatility in the prices of food commodities which has grossly impaired attainment of food security. With the recent shift in focus to agriculture in Nigeria, there have been clamours for reintroduction of the commodity boards. While some are in doubt of the efficacy of such boards due to the entrenched corruption and tendencies for mismanagements that may usurp their essence, others support and advocate that re-introducing the board will be providing a structure that supports price stability. The study investigated volatility in the prices of three key crops in Nigeria – maize, sorghum and yam in the pre- and post-market liberalization eras. Using data on annual producer prices of the food commodities from 1970-2017 sourced from the Food and Agricultural Organization statistical database for the United Nations, the study examined volatility in the food prices and disaggregated into pre- and post-liberalization eras. Analytical procedure involved data detrending, standard deviations and independent sample t-test. Our result showed that volatility in the prices of all three crops examined astronomically increased in the post-liberalization era. Variations in prices have tended to be permanent in nature rather than transitory. Maize prices were the most volatile in the period under review. The study therefore recommended de-liberalization of agricultural markets provided a robust framework is in place to support the workability of the system.

Keywords: Food commodities, Food security, Market liberalization, Producer price, Volatility

INTRODUCTION

Volatility in food prices has been an issue of global concern given its potential ability to destabilize or even disrupt food security agenda of any nation especially when the price surges are upwards in nature. One may argue that rising prices are more likely to be beneficial to the food producers and middlemen to whom more revenues may accrue. However, there are far reaching underlining effects that will impact negatively on: consumers who purchase these food commodities, the general price

level and invariably the economy hence ultimately eroding the recorded benefits to producers at the onset. In many countries, Nigeria inclusive, the government has in time past played major roles in ensuring price stabilization in the food markets, key among which is the operation of the commodity boards which is not without its own shortcomings. Given such responsibility as setting commodity producer prices, it is rational in some cases for producers to be laid back in their productive capacities.

According to Ajetomobi (2010), Nigeria is among many African countries that have engaged in agricultural liberalization since 1986 in the hope that reforms emphasizing price incentives will encourage producers to respond. However, the reforms seem to have introduced greater uncertainty into the market given increasing rates of price volatility.

In recent times, there have been conflicting schools of thoughts, arguing for and against the re-introduction of agricultural marketing boards in Nigeria. Common argument in literature asks questions on whether market liberalization and deregulation of domestic markets in developing countries resulted in increased incentives for agriculture (Adeoti, Popoola, and Aremu 2013). While some are in doubt of the efficacy of marketing boards due to the entrenched corruption and tendencies for mismanagements that may usurp the essence of the boards, others support and advocate that re-introducing the board will be providing a framework that supports price stability, raise propensity to produce thereby promoting food security. This study is motivated by the need to gain insight into trend of food commodity prices in Nigeria. In order to get a broader outlook, the study disaggregates the period examined into pre- and post-market liberalization era.

The study seeks to answer the following research questions: what is the magnitude of price volatility in selected staples in Nigeria over the years? How have prices of food commodities in the pre-liberalization era compared with the prices in post-liberalization era? The specific objectives of the study are to: evaluate volatility in the prices of three selected staple foods in Nigeria in the period 1970-2017, and to compare the prices of the selected staple foods in the pre- and post- market liberalization era. This study is justified because the crux of agricultural liberalization is food price stabilization. It is therefore necessary to ascertain that this strategy is essentially achieving the motive for which it was introduced.

LITERATURE REVIEW

Food prices have been volatile over the years and this is a source of concern across various climes and regions, among crops, between processed and unprocessed foods and even between traded and non-traded goods (Gilbert and Morgan, 2010; Minot, 2014). Countries have been affected in diverse ways and it can be said that

developing countries might have been worse hit given the high poverty rates and poor response to looming challenges in the face of economic hardships. Boto and Lopes (2011) submitted that "Excessive price volatility and price spikes are one of the most critical economic and food security challenges facing global policymakers today. Moreover, spikes in food prices can have significant impact on incomes, markets, and nutrition worldwide. In extreme cases, they can have serious political and social repercussions; in the 2007-08 food price crisis, 33 countries saw violent riots and social unrest as a result of volatile food prices, while in 2011, food price spikes have been at least partially blamed for riots in several countries".

Statistics have shown that international and domestic food prices spiked multiple times in the past years and have continued to remain volatile. This development is considered to have serious implications, especially for the poor who spend the larger proportion of their incomes on food. Furthermore, price volatility poses a challenge to macroeconomic stability and can disincentivise food production (Banerjee and Duflo, 2007; Haile et al. 2013). The exigencies for food security encompass food availability, accessibility and affordability by the populace and it is quite paradoxical since food availability is premised fundamentally on production. Recognizing the potency of agricultural productive capacity towards sustainable food system, nations took on various agricultural reforms and in fact, the World Bank and International Monetary Fund introduced some agricultural reforms targeted at boosting production and fostering competitive market as preconditions for bailout for governments.

The agricultural reforms introduced by the World Bank and International Monetary Fund were designed to reduce or eliminate the bias against agriculture that was subtly in existence prior to that time and this was with the intent of opening up the sector to market forces rather than government influences. Taking cue from evidence of some other countries, Nigerian Government loosened the grip on commodity markets and from the late 1980s, the country explored various agricultural marketing reforms with liberalization at the core, key among which is the eradication of commodity marketing boards. According to Adeusi, Azeez and Olanrewaju (2012), Structural Adjustment Programme (SAP) was one of the major reforms embarked upon by various countries especially the developing countries in the 1980s. The aims of the reform were to rectify the prevailing macro-economic and structural imbalances in the economy, to restructure and diversify the productive base of the economy, lessen dominance of unproductive investment and to achieve fiscal and balance of payment viability.

Market liberalization is a prominent component of Structural Adjustment Programmes which has underlining role to play in economic reforms in developing countries. It is assumed that market or trade liberalization will shift internal terms of

trade in favour of farmers as the real prices received by farmers will improve with the dismantling of structures the government used to suppress food prices such as subsidies, price ceiling mechanism, territorial pricing and commodity boards given that it is structured such that it entails the removal of import quotas and other quantitative restrictions, abolition or reduction of the level and dispersion of import tariff rates, removal of export taxes, removal of protection for local industries and export subsidies, elimination of non-tariff barriers, and devaluation of the local currency (Timmer, 1986; Olomola *et al.* 1996).

Badmus (2010) stated that Nigeria adopted the more market-based policy measure in July, 1986. The policy instrument measures aimed at institutional reform entailing the abolition of the commodity boards and the adjustment of the exchange rate. Thus, a market-determined exchange rate was adopted from September, 1986, and interest rate from July, 1987. The desired structural change and growth of the Nigerian economy was partly anchored on the development of the agricultural sector, when the structural adjustment program (SAP) was launched in mid- 1986. This was so, given the crucial role of agriculture to change in the structures of Sub-Saharan African economies and to the development of Nigeria's economy in particular (Oyejide, 1990; Badmus, 2010)

METHODOLOGY

The study was carried out in Nigeria located in West Africa on the Gulf of Guinea. Nigeria, sharing land borders with the Republic of Benin in the west, Chad and Cameroon in the east, and Niger in the north, has a total area of 923,768 km² (356,669 sq mi). The nation is endowed with a diverse climate and landscape, ranging from the equatorial climate of the southern lowlands, through the tropical central hills and plateau, to the arid northern plains which mark the southernmost extent of the Sahara desert. Nigeria is Africa's most populous country and one of the ten most populous countries in the world. The population is growing rapidly, rising from 88.9 million in 1991 to 140 million in 2006 and 193.4 million in 2017 (NPC, 2017). The country is endowed with rich natural resources, of which oil and gas have been the mainstay of the economy in the last few decades, providing 20% of GDP, about 95% of the foreign exchange earnings, and up to 65% of the nation's budgetary revenues (World Factbook, 2012). Up to 70% of the population is engaged in agricultural production.

This study employed time series data on annual producer price of selected food commodities in Nigeria. The food commodities selected for this study include maize, sorghum and yam due to their prominence as staples and also their high trade-ability in the market in Nigeria. The period under investigation ranged from 1970 to 2017. The price data were secondarily sourced from Food and Agricultural Organization

statistical data base for United Nations and the World Bank. Availability of data as well as the nature of the study which entails comparing the food prices pre- and post-liberalization informed the decision on the period to collect data on. The interest basically is to assess volatility in the food commodity prices over the 48-year period and compare food prices in the period before and after market-liberalization. Data collected on the commodity prices were analyzed using descriptive statistics such as standard deviation of the commodity prices as a measure of volatility, graphs, and the independent sample t-test.

Volatility indicates the pricing behaviour of a commodity and helps estimate the fluctuations that may happen in its prices. In order to determine the volatility in the prices of maize, sorghum and yam for the period under investigation, descriptive statistics was used. According to Gilbert and Morgan (2010), volatility, a unit free measurement, is a directionless measure of the extent of the variability of a price or quantity. Volatility measure is obtained from the second moment of the distribution of the prices being examined, or the corresponding transformations. Following previous studies, Volatility is often regarded as variance and it is a measure of the dispersion of a random variable from its mean value. Thus, price volatility relates to the fluctuations (or instability) in price around its mean value over time or the risk of large, and unexpected changes in price (Omotosho and Doguwa, 2012; Tadesse *et al.*, 2014; Kalkuhl *et al.*, 2016; Shittu, Akerele, and Haile, 2017).

In order to ensure the veracity of the results from measuring volatility, it becomes pertinent to carry out certain processes on the time series data to be used for the analysis to ensure avoidance of capturing trend movements as a part of volatility. One very germane process involves detrending the data to be used given that demonstration of trend is highly characteristic of time series. Detrending is a process that involves the removal of any form of biases or offsets from the time series data such that the resulting time series fluctuate approximately about zero (0) hence enabling assessment of the particular fluctuations in the prices under consideration. Basically, detrending series of data entails forcing the means towards zero; thereby reducing overall variations and giving the actual volatility which is the point of interest in this objective. The procedure was carried out using Excel detrend function. Detrending the data resulted in a time series that is stationary which is a basic requisite in order to be able to carry on with the analysis on volatility which is being examined. The aim of detrending process is to make the time series stationary as this is a basic assumption in working with the series. According to Hyndman and Athanasopoulos (2013), a stationary time series is one whose properties do not depend on the time at which the series is observed whereas time series with trends, or with seasonality, are not stationary hence the trend and seasonality will affect the value of the time series at different times.

Following detrending of the historical average annual producer prices of the selected

commodities under investigation, a stationary time series data was obtained from which Inter-year price changes were calculated as shown in Equation 1:

$$\text{Inter-year Price changes, } \Delta P = \left(\frac{P_j}{P_i} \right) - 1$$

Where P_j = Price in the j^{th} year
 P_i = Price in the $(j-1)^{\text{th}}$ year i.e. previous year

Following this, the standard deviation of the Inter-year price changes were calculated using the standard deviation function in Excel.

In order to compare prices of the selected staple foods in the pre- and post-market liberalization era, the independent sample t-test was employed. This was to ascertain whether there was a significant difference in prices of the selected food commodities during the pre- and the post-liberalization era. The pre- and post-liberalization periods examined are 1970-1985 and 1986-2017 respectively. The null hypothesis was that there was no significant difference between food crop prices in the pre- and post-SAP era in Nigeria.

The t-test statistics for each of the selected crops may be calculated as follows:

$$= \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2_1}{n_1} + \frac{S^2_2}{n_2}}}$$

where

$\bar{X}_1$ = Mean price (N) during the pre-liberalization era

$\bar{X}_2$ = Mean price (N) during the post-liberalization era

S^2_1 = Variance of price (N) in the pre-liberalization era

S^2_2 = Variance of price (N) in the post-liberalization era

n_1 = Number of observations (years) in pre-liberalization era

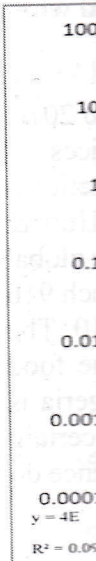
n_2 = Number of observations (years) in post-liberalization era

In this case, the t-test for the difference in means of selected food crop price is an hypothesis test that tests the null hypothesis that the mean price of the selected food crop for both the pre-liberalization and post-liberalization era are equal, whereas the alternative hypothesis is that the mean price of food crops are not equal (2-tail) or that the mean price of the food crop in one of the periods is larger than that of the other period (1-tail). Interpreting the t-test result entails comparing the p-value of the t-test statistic to the chosen p-value which was set at 0.05 in this study. While the t-test statistic may as well be calculated manually, the GRETTL statistical package was used for the analyses in this study.

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the Nation of 1976 – 1979 and the Green Revolution of 1980-1985 during which zero volatility were experienced in the price of maize. This implies the strategies were highly impactful in price stabilization of maize hence the zero volatility which may also have some linkage with the Strategic Grain Reserve implementation of 1976.

Notably, volatility in maize prices in the years closely following 1985 were still relatively stable despite the ban on maize imports in 1985 which implies the ability of the system to support consumption from local production. During the Post-Structural Adjustment Programme which started in 1994 till date, there has continued to be observations of volatility with some of them being profound while some were mild, however there has been no flattening out over time.

Taking a broader look at volatility in food prices globally, from year 2006 to 2010, some unanticipated shocks were experienced in the world dollar prices of commodity especially food commodities and there were large peaks in international food prices especially in the periods 2007-2008 and 2010-2011 (Abbot, Hurt & Tyner, 2008; Mitchell, 2008; Gilbert, 2010). Nigeria was not left behind in the global scenario as it can be seen that volatility in price of maize increased by as much 916 percent between 2007 - 2008 and even further by 559% between 2009-2010. The experiences in Nigeria being consistent with what went on globally in the food commodity market in the periods aforementioned is an indication that Nigeria is impacted and also impacts on the world food commodity market even though certain food commodities produced in Nigeria do not yet meet the world standard hence do not attract a premium as such in the market place.

During the post liberalization era which started in 1986, there had been so many occasions where volatility fluctuated dramatically. It is however note-worthy that the upwards surges experienced in maize prices volatility far exceed those in which there were drops in prices. In addition, the variations in prices have tended to be permanent in nature rather than transitory as can be observed in the measure of volatility over the period under investigation. This has strong implications for food security in Nigeria. The fact that per capital income has failed to grow at the pace at which staple prices have increased impairs the household's ability to purchase food in the required quantities that will make them food secure.

According to Hernandez, Robles and Torero (2011), the increase in food prices and its inflationary consequences have mainly penalized poor populations, notably in developing countries as these populations derive a large proportion of their income from trade in basic food product. As an addition to this, Ano-Sujithan, Avouyi-Dovi and Koliai (2014) submitted that food security and food price stability have become major concerns for most governments throughout the world.

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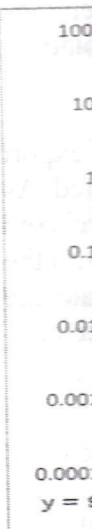


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As shown in Figure 1, a polynomial trend line was fitted in the graph showing dynamics of volatility in the producer price of maize and one could observe a very low R-squared value of 0.0989 which implies the graph is not a good fit of the line to the volatility data plotted. A trend line with a R-squared value closer to 1 would have been able to closely estimate values for volatility in maize price for future periods.

One may draw inference from this as the inability of the trend line to closely estimate volatility in the subsequent years implies that very little can be explained of volatility experienced in the price of maize based on the historical volatilities hence making predictions a bit impaired.

Volatility in the annual producer price of sorghum in the period under investigation is presented in Figure 2.

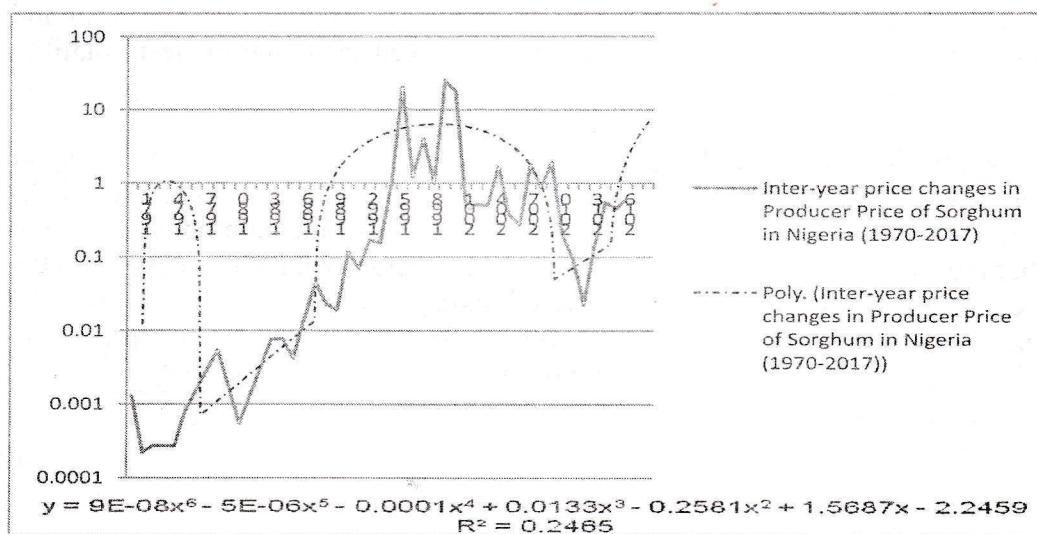


Figure 2: Volatility in Annual Producer Price of Sorghum in Nigeria (1970-2017)

From figure 2, one can observe the persistence of volatility in the price of sorghum throughout the period being investigated and with most of the volatility showing an upward trend. There were a number of dramatic fluctuations however these were not as peculiar as those observed in maize price volatility.

With a standard deviation of 5.588646 in the inter-year producer prices changes of sorghum in Nigeria, volatility in the price of sorghum can be said to be relatively stable when compared to the volatility in prices of maize within the same period. A polynomial trend line fitted on the volatility graph plotted with a low R-squared value of 0.2465 indicates the inability of the fit to correctly estimate and predict future volatility based on the historical volatility observed over the years which

implies there are so many unexplained causes of variations in the prices of food commodities.

Considering the Pre-liberalization era, the periods in which zero-volatility were experienced in the price of sorghum coincided with the Operation Feed the Nation of 1976 – 1979 and the Green Revolution of 1980-1985. It further confirms the efficacy of those programmes and strategies in price stabilization of food commodities in Nigeria. Similarly, in the pre-liberalization era, volatility was observed to be relatively steady especially in the period 1972-1975 while the first major upward surge in volatility was observed post-liberalization in the 1986/87 period. There was a 341% rise in sorghum price volatility and this coincided with the commencement of the Structural Adjustment Programme of 1986 which is in the Post-liberalization era. Even higher rise in volatilities were experienced in the Post-SAP period with the highest observed in 1996 and 2000 with volatilities as high as 1,990 per cent and 2,590 per cent respectively and these were observed to be the highest volatility experienced during the period of study.

According to Okuneye (2001), Trade liberalization stimulated the growth of export of agricultural commodities in Nigeria while its serious implementation lasted. As usual with the country, the implementation of trade liberalization policies relaxed with time and the boost in the agricultural export sector took a down turn. With the advent of democracy, massive imports of luxury goods began to dominate the economic scene which had resulted in a gross neglect of the food production sector of the Nigerian economy since the Structural Adjustment Programme (SAP).

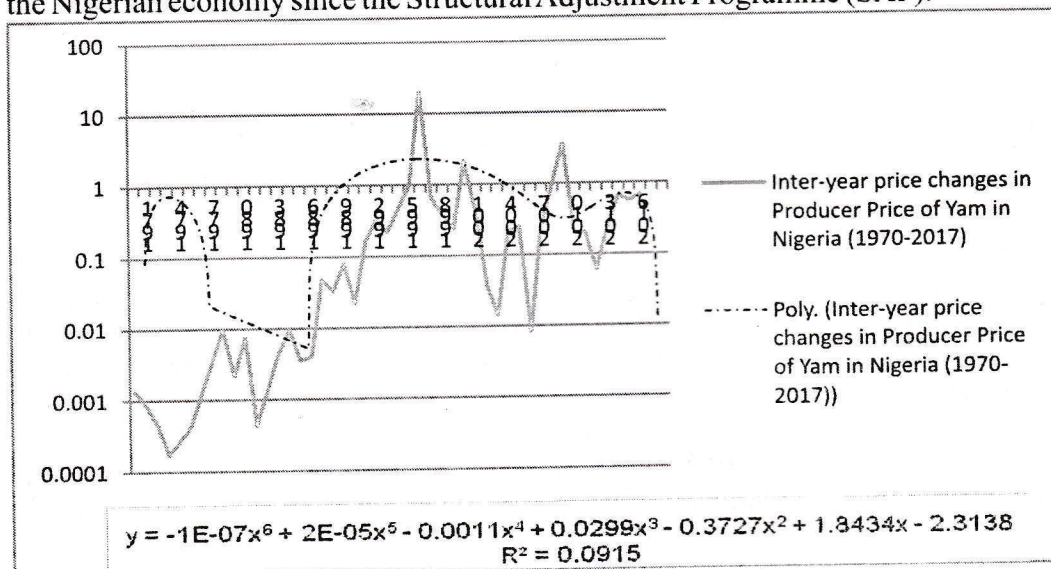


Figure 3: Volatility in Annual Producer Price of Yam in Nigeria (1970-2017)

Volatility in the price of yam is as presented in Figure 3 from which it can be observed that the volatility in the price of yam is lower than those observed in the prices of maize and sorghum in the period under investigation. Similar to observations in maize and sorghum, periods of zero volatility in yam price in Nigeria also occurred in 1975, 1977, 1978 and 1983 which were during the programmes of Operation Feed the Nation and Green Revolution. These periods of zero-volatility all occurred in the pre-liberalization era and may be indicative of better stability in prices when there were government interventions in commodity pricing in Nigeria. The largest measure of volatility was experienced in 1997 with a volatility of 2,015 percent above what was experienced in the previous year of 1996. Following the end of the Structural Adjustment Programme in 1993, volatility in the price of yam in the immediate year declined and then there was a rise which has persisted. The spike in price that was observed in 1996 has become permanent in nature as there were no returns to the previous prices but rather volatility in prices persisted and with another significant rise observed in year 2010 where volatility increased by 377 percent over what was observed in the previous year. The trend line fitted for volatility is unable to correctly estimate the volatility expected in the future given the low R-squared value of 0.0915 which also implies that very little can be explained of the expected future volatility based on historical volatility that have been experienced in yam over the years.

Contrasting Volatility in the Annual Producer Price of Maize, Sorghum and Yam in Nigeria 1970–2017

Table 1 indicates the volatility measures as well as results of the t-tests carried out on volatility in prices of the commodities of interest which are maize, sorghum and yam.

Table 1: Volatility Measures in Selected Commodity Prices 1970-2017

S/N	Commodity	Volatility measure during Pooled (1970-2017)	Volatility measure during Pre-SAP period (1970-1985)	Volatility measure during Post-SAP period (1986-2017)
1	Maize	8.112173	0.002146	10.11231
2	Sorghum	5.588646	0.002809	6.980492
3	Yam	3.007746	0.00375	3.760014

***On the overall, it can be seen that volatility in the producer price of Maize is far higher than those of sorghum and yam. At a measure of 8.112173, volatility in the prices of maize during the period under investigation was about 145 per cent and 270 per cent of the volatility observed in the prices of sorghum and yam respectively. This

implies that the variations experienced in the prices of maize over the years is far higher than those experienced in the other two commodities being examined and this may fundamentally be linked to the high relevance of maize both locally and internationally above sorghum and yam hence subjecting maize to a higher number of factors that influence price changes in commodity marketing. This finding is in tandem with that of Kornher and Kalkuhl (2013) where it was mentioned that volatilities are different between countries and crops with maize in Africa exhibiting the highest price instability.

In Nigeria, maize and sorghum are important cereals which are commonly consumed, having highly competitive alternative uses in the livestock feed and brewery industries respectively. The alternative industrial uses for maize and sorghum may put pressure on the supply of these staples for human consumption and these could have very strong implications for food security of the populace. Bio-fuel production may not be considered a strong threat to the availability of grains for human consumption in Nigeria in the current state. However, with the advancement in bio-fuel production, closer attention will be required in order to be able to ensure sustainability. Yam, although a very important staple crop in Nigeria, does not command the same level of importance as grains such as maize and sorghum in the global market and this may account for why yam price does not experience the high level of volatility observed in the other two crops investigated. Findings from this study were consistent with that of Adeoti, Popoola, and Aremu (2013) in a study investigating the effect of market liberalization on maize price distributions in Nigeria where they found general increase in food prices in the period under review however, with the degree of variation being lower in the pre-liberalization period relative to the post liberalization period and with the highest price variability experienced in the short term period after the reform.

Table 2 presents the t-test results indicating how average prices of the selected food commodity prices compared in the pre- and post- liberalization era. The test sought to ascertain whether mean price of the selected food commodities in the post liberalization era significantly differed from their mean prices in the pre-liberalization era.

Table 2: T-test results of Food Prices in the Pre- and Post-liberalization Era

T-test Statistics Result For Maize Price				
Period	N (Years)	Mean	Standard Deviation	Standard Error Mean
Pre-SAP	16	0.174375	0.102174	0.0255436
Post-SAP	32	34.7353	27.4348	4.84983
Test statistic: t (46) = 5.01182			Two tailed p-value = 8.448e-006	
T-test Statistics Result For Sorghum Price				
Period	N (Years)	Mean	Standard Deviation	Standard Error Mean
Pre-SAP	16	0.1725	0.119638	0.0299096
Post-SAP	32	31.25	24.9673	4.41364
Test statistic: t (46) = 4.95204			Two tailed p-value = 1.032e-005	
T-test Statistics Result For Yam Price				
Period	N (Years)	Mean	Standard Deviation	Standard Error Mean
Pre-SAP	16	0.318125	0.265235	0.0663087
Post-SAP	32	37.5097	26.5808	4.69886
Test statistic: t (46) = 5.56645			Two tailed p-value = 1.286e-006	

Source: Data Analysis, 2018

The t-test statistics obtained in all three crops (maize - 5.01182; sorghum - 4.95204; and yam - 5.56645) were found to have p-values of $8.448e-006$, $1.032e-005$, and $1.032e-005$ respectively hence our rejection of the null hypothesis. It therefore implies that the difference in food crop mean prices were statistically significant at 5%. The result obtained revealed that prices of the selected food crops were generally higher in the post-liberalization era than pre-liberalization era. The finding that prices of food crops were significantly higher in the post-liberalization era therefore raises concern as to the efficacy of market liberalization strategy in food price stabilization in Nigeria. In their study on food price volatility in developing countries and their determinants, Kornher and Kalkuhl (2013), expressed surprise at the inability of the various instruments that have been implemented to stabilize food prices in many countries. They stated that over the last 20 years governments in developing countries have been told to liberalise markets and reduce public market intervention and that food price volatility may pave the way for the reincarnation of protectionism and public interventionism. It is however important to mention that Newbery and Stiglitz (1981) believe that these policies come at high economic and fiscal costs and there is no guarantee that market interventions reduce domestic price volatility.

CONCLUSION AND RECOMMENDATIONS

The study concluded that the highest price spikes in maize, sorghum and yam occurred in the post-liberalization era whereas maize exhibited the highest volatility

of all the three crops under investigation. Variations in prices have tended to be permanent in nature rather than transitory as can be observed in the measure of volatility over the period under investigation and this has strong implications for food security in Nigeria. Furthermore, there were significant differences in food commodity prices in the pre-SAP era and post-SAP era suggesting that volatility in the price of these two commodities were indeed higher in the post-liberalization era than during the pre-liberalization era. Having established that volatility is highest in maize, it becomes important to pay attention to the commodity considering its importance not only as a commonly consumed staple but also its usefulness in the livestock feed industry hence the indirect role it has to play towards protein requirement fulfilment in food security and also its industrial use in biogas production which will gain even more grounds in the future. Yam indicated the least volatility which suffices that the commodity may be of pro-poor importance. Based on the foregoing, the continuity of agricultural programmes that have records of good performances should not be discarded with change in administration. Having found that price volatility was higher in the post-liberalization era, the re-introduction of marketing board which is theorized as a market de-liberalization strategy in this study may become necessary especially within the framework of better regulated markets. This is on the basis that market liberalization has not demonstrated to fulfil one of its aims which is to stabilize food crop prices in Nigeria. In order to attain food security as a nation, it becomes paramount to put such measures that enhance food affordability in place.

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