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Analysis of determinants of maize price variations in Nigeria (1978 - 2014)

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ABSTRACT

Skyrocketing prices of food staples such as maize can lead to inefficient agricultural production and definitely have detrimental effects on the economic, social, and political growth of any country. Most studies on maize in Nigeria are focused on the increasing consumption or competitiveness, very few address the determinants of maize price change as a panacea for the increase of productivity. Filling this gap requires a study on the various factors that contribute to the variations in the price of maize. In this study, secondary data were used. The study used descriptive statistics tools to analyze the pattern of price variations and changes in the production of maize over a period of 36 years in Nigeria. Also, various factors affecting price variation of maize were examined. It was recommended that the positive and significant impact of country's population to maize price change should serve as an impulse to encourage investment in agricultural sector of Nigeria in order to ensure food security in the country. Also, the government should use the inflation measures to regulate prices of maize in the country.

Introduction

Soaring food price is a major concern all around the world, especially in developing countries and many studies are being concentrated on the causes and solutions to these reported skyrocketing food prices (Ayinde and Idris, 2005; Abbot et al., 2009; Gilbert, 2010 and Ayinde et al., 2016). Both developing and developed-country governments play important role in bringing prices under control and in helping poor people cope with higher food bills. Presently, there are no indications towards reasonable levelling of food prices and between 2007 and 2008 alone the food price index calculated by the Food and Agriculture Organization of the United Nations (FAO) rose by nearly 40 percent, compared with 9 percent the year before, and drastic increases have been seen all over the world since then. The combination of new and ongoing forces is driving the world food situation and, in turn, the prices of food commodities. One emerging factor behind the rise of food prices is the high price of energy (FAO, 2005). The growing world population is demanding more different kinds of food. Rapid economic growth in many developing countries has pushed consumers' purchasing power up and there is an increasing shift from traditional staples (Eleanore, 2013; IFPRI, 2008). The daily consumption of poor households is presently at risk when they are not shielded from the price rises (FAO, 2005). Higher food prices lead poor people to limit their food consumption and this definitely results in unbalanced diets and rations, with harmful effects on health in the short and long run.

Unstable prices for important food staples such as maize can have acute economic, social, and political consequences, which inevitably lead to inefficient agricultural production all around the world (Ayinde et al., 2016; Gilbert, 2009). In Nigeria, maize consumption in the average household diet has been transformed from being a luxury food item to that of a staple which is gradually taking part of the share formerly accounted for cassava and yam (Odushina, 2008). A rapid urbanization and the ease of preparation of this cereal makes it fit easily to the

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lifestyle of urban workers (FAO, 2005). Maize is believed to be the most often consumed staple, with 20% of the population eating it at least once a week (IITA, 2004), but the average yield is low when compared to the world average of 4.3 tonnes/ha. It is even lower when compared to the average yield from other African countries like South Africa, Mauritius and Egypt with average of 2.5 tonnes/ha, 5.8 tonnes/ha and 7.1 tonnes/ha, respectively (FAO, 2009). The Food and Agricultural Organization data indicated the increase in maize production in Nigeria, partly because of the plant ability to strive in different ecological zone within the country. Ogunsumi et al., (2005) stressed the economic impact of maize in Nigeria and indicated that 30% of land has been devoted to maize cultivation and also reported the increase in maize production in the effort to combat hunger in poor households and also to increase food production across Africa. The increase in maize production from 612 thousand tonnes to 70195 thousand tonnes has been reported by Alabi and Esobha-wan (2006), representing 1000% increase. The research also emphasized that 561397.29 hectares of arable land in Nigeria has been put into maize production with the increase in the crop price, pointing out the importance of maize in the country's economy.

Nigeria, being a net food importer, is at a largely disadvantaged by the increase in food prices currently experienced in the country. Net food importers, however, will struggle to meet domestic food demand. Given that almost all countries in Africa are net importers of cereals, they will be hit hard by the rising prices (FA0, 2009). Nigeria is the largest maize producer in Africa and the tenth largest producer of maize in the world (IITA, 2012). The majority (about seventy percent) of farmers are smallholders accounting for 90 percent of total farm output (Cadini and Angelucci, 2013). In Nigeria, maize crop was firstly farmed on the subsistence level and has over the years risen to a commercial crop which many agro-based industries depend on. It has been used as raw materialfor their individual production, and increase in the price of maize over the years is a threat to the continuous production of these industries (Ayinde and Idris, 2005 and Iken, and Amusa, 2014). Maize is most productive in the middle and Northern belts of Nigeria, where sunshine is adequate and rainfall is moderate (Obi, 1991). Over the years, the variation in prices of food in Nigeria has been continually attributed to a number of factors including variances in the bargaining power among consumers, cyclical income fluctuations among sellers and consumers, natural disasters such as flood, pests, diseases, and inappropriate response of farmers to price signals (Ayinde et al., 2016). However, this study seeks to take a detailed look at the determinants of maize price variations in Nigeria. The specific objectives are to examine the pattern of maize price variations and production in Nigeria and to analyze the factors responsible for maize price variations in Nigeria over the period of 36 years.

Literature review

Divergence occurring between planned output and realized output can lead to price fluctuations as well as seasonality in production and marketing. There are two distinct types of price variations, the seasonal price variation and the cyclical price variation. The seasonal price variations are regular patterns of price fluctuations that occur within a year. The cyclical price variations repeat themselves regularly with the passage of time. Many studies have been carried out to investigate the causes and solutions to soaring food prices (Ayinde et al., 2016; Abbot et al., 2009; Gilbert, 2010). They examined and identified a set of causes of food price upsurges including export, production, speculations in commodity future markets, countries' aggressive stockpiling policies, inflation, trade restrictions, exchange rate and the economic growth. In Nigeria, export prices fluctuate as the result of currency devaluation, which is expected to be an incentive for export growth. The primary concern is the nature and magnitude of risk introduced by the price and exchange rate movements in agricultural exports. A lot of researchers who conducted researches on the effects of price and exchange rate movements on agricultural tradable products either had inconclusive results or considered too few variables in their analysis, leaving a gap in this area. Ayinde et al. (2016) considered only export, production, import, land area, exchange rate and inflation as the only drivers of rice price variations in their study area. Kargbo (2006) found that prices, real exchange rates, domestic production capacity, and real incomes have significant impacts on the agricultural export. Explosive increase in prices were identified by researchers during the 2007–2008 spikes (Gilbert, 2009; Phillips and Magdalinos, 2009, Ayinde et al., 2016). Pindyck and Rotemberg (1990) analyzed the co-movement of seven unrelated commodities. They used various macro-economic variables such as interest, inflation, and exchange rates but also supply and demand conditions to explain the co-movement. It was discovered that after controlling of these factors, a phenomenon Pindyck and Rotemberg dubbed as excess co-movement was discovered.

Most empirical studies focus primarily on granger causality tests to explain the role of speculation in price volatility (Ayinde et al., 2016; Irwin et al., 2009; Gilbert, 2010). Akpan and Udoh (2009) used the ordinary least squares method to estimate grain relative price variability and the inflation rate movement in different agricultural policy regimes in

Nigeria. The major findings were that the inflation had a positive significant impact (at the 5% significance level) on relative price variability of grains in Nigeria. Ettah et al. (2011) used ordinary least squares method to estimate the effects of price and exchange rate fluctuations on agricultural export in Nigeria. The major findings were that the exchange rate fluctuations and agricultural credits positively affected cocoa export in Nigeria. The adopted methodology in this study will add to knowledge by examining the trends in maize price change over the years andalso by identifying the drivers in the variations and prices of maize. This study goes a little further to analyze various factors that determine variations in the price of maize. Since spikes and volatility are the major indicators of food crises, it observes the long run relationship that exists between various variables, as well as their trend.

Material and methods

Scope of study

This study used time series data of a period of 36 years, spanning from 1978 to 2014, obtained from various sources They are various bulletins which include editions of National Bureau of Statistics review of external trade, Central Bank of Nigeria's economic and financial review and an online database maintained by Food and Agricultural Organization (FAO).

Analytical technique

Descriptive statistics

The descriptive and inferential statistical technique such as graph is used to show the pattern of price and production of maize.

Unit root test

The Augumented Dickey-Fuller (ADF) is used to test the stationarity or non-stationarity. Stationary series are the ones with a mean value which will not vary within the sampling period. Nonstationary series will exhibit a time varying mean (Dickey and Fuller, 1979 and Juselius, 2006). Ordinary least squares can be used in time series analysis as long as the variables are stationary (Gujarati, 2003).

Co-Integration analysis

This involves testing for the existence of a long-run equilibrium relationship. Co-integration naturally arises in economics and finance. In economics, co-integration is most often associated with economic theories that imply equilibrium relationships between time series variables. However, for conducting the co-integration analysis there are various techniques. Econometric literature has abundant econometric techniques to examine co-integration relationships. The most popular approaches are the well-known residual based approach proposed by Engle and Granger (1987) and the maximum likelihood-based approach proposed by Johansen and Julius (1990). In performing the co-integration technique, we need to determine the order of integration for each variable. However, both of the approaches require that the variables have the same order of integration. Johansen-Juselius introduce two statistics for determining the number of co-integrating vectors. These are known as max and trace tests. Co-integration process integrates short-run dynamics with long run equilibria (Maddala, 2001). The analysis of short run dynamics can be done by firstly eliminating trends in the variable that is making the variables to be at the same level by making non-stationary variable stationary. This analysis firstly involves the test for unit root or stationary test. The Augmented Dickey-Fuller (ADF) test was used for the test. The ADF F-ratio critical value was used to make decision on the stationarity of the variables. Johansen technique was used not only because it is vector auto-regressive based but because it performs better in multivariate model.

$$LY_t = \beta_0 + \beta_1 LX_{1t} + \beta_2 LX_{2t} + ... + U_t,\ t=1,2,\dots,36$$

where Y_t = maize price in year t, X_{1t} = maize production in year t, X_{2t} = maize area planted in year t , X_{3t} = inflation in year t, X_{4t} = Nigeria population in year t, X_{5t} = maize import in year t, X_{6t} = maize export in year t, X_{7t} = National agricultural budget in year t, X_{8t} = exchange rate in year t, t = time, U_t = Error term associated with time t.
The error term was tested for unit root for re-confirmation of co-integration.

Results and discussion

The results from Table 1 show descriptive statistics, where mean production, minimum production and maximum production were analysed for the data series of maize. It shows that the maize has an all-time maximum production of 10,791,000 tonnes and an all-time minimum production of 5,088,800 over the considered time period. The all-time maximum price is 82,452 while the maximum area of land used in production is 5,849,800ha.

Table 1. Descriptive Statistics Table of Variables

	N	MINIMUM	MAXIMUM	MEAN	STD. DEVIATION
PRICE	36	130.000	82452.000	23427.000	24336.000
PRODUCTION	36	4.8800e+005	1.0791e+007	5.0888e+006	2.6429e+006
EXCH. RATE	36	0.45000	183.000	63.204	65.052
INFLATION	36	5.3822	72.836	19.578	17.469
AREA	36	4.2500e+005	5.8498e+006	3.4813e+006	1.6911e+006
IMPORT	36	0.00000	1.0256e+005	9996.200	22173.000
EXPORT	36	0.00000	1400.000	154.220	312.740
BUDGET	36	1.0180e+008	8.7859e+010	1.0640e+010	1.8675e+010
POPULATION	36	69512.000	1.7748e+005	1.1542e+005	31892.000

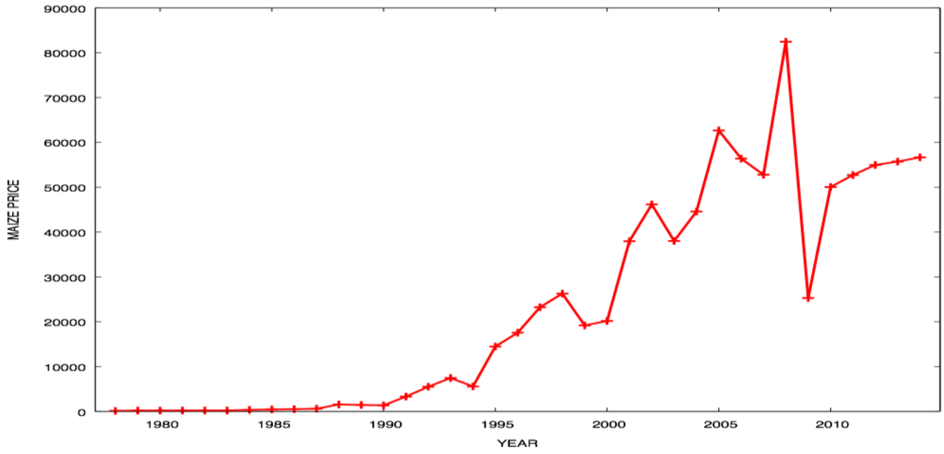

Fig. 1. Pattern of Maize Price

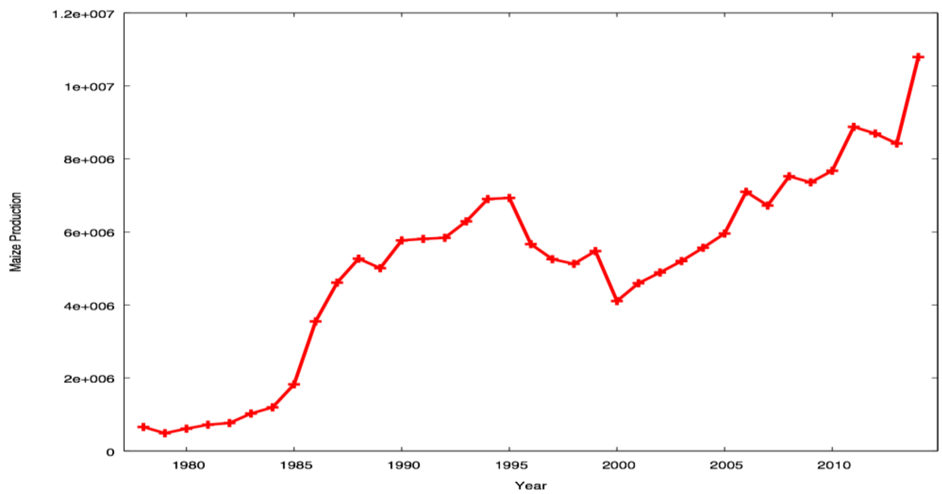

Fig. 2. Pattern of Maize Production

It can be seen from Fig. 1 that from 1978 the price of maize in Nigeria was relatively stable till 1990, from where it took on different series of lows and highs at an unprecedented rate. The lowest price then was in

1994 and the all-time highest price of maize was in 2008. This appears to have been the result of 2008 price spike when most agricultural prices and many non-agricultural prices (energy, metals and freight rates) rose simultaneously (Abbot et al., 2008; Mitchell, 2008; Cooke & Robles 2009; Gilbert 2010). The trend of maize production is shown in Fig. 2. Maize production was relatively steady from 1978 to 1984 with little increases over these years. The production increased at a relatively increasing rate from 1985 to 1995. The lowest quantity was 5,088,800 tonnes in the year 2000. From 2000 to 2014 production statistics show a steady increasing trend in production, associated with the decline between 2006 and 2009, with the highest production of 10,791,000 tonnes in 2014. Possible reasons for fluctuation could include higher costs of production than usual in some years, the impact of rural urban migration and climate impactsas well.

Unit root test

In building time series models, data used are supposed to be stationary. If nonstationary data are used in a model, the results may indicate a relationship that is misleading. So, before identifying the model, time series data have to be tested for stationarity. Stationary data are the ones whose statistical properties do not change over time. If any of these characteristics are not met, the data are declared nonstationary (Studenmund, 2016). More formally, a time series is stationary if it is characterized with the constant mean and variance, and an autocovariance that does not depend on time (Ramasubramanian, 2001). Table 2 shows the results of the unit root test for stationarity in all variables using the Augmented Dickey Fuller (ADF) test. All the variables are non-stationary at this level but became stationary at their individual first difference.

Cointegration analysis

Since the variables were non-stationary at level but stationary at first difference, the next stage involves testing for the existence of a long-run equilibrium relationship. The Johansen and Juselius (1990) technique was employed since the variables have the same order of integration. Johansen-Juselius introduce two statistics for determining the number of co-integrating vectors. These are known as max and trace tests. Meanwhile, Akaike Information Criterion (AIC) is employed as lag selection criterion.
Tables 3 and 4 present the co-integration results for the model. Here, it is observed that the variables in the equation are co-integrated. The trace value indicated the presence of seven (7) co-integrating equations and the max-Eigen values indicated the presence of five (5) co-integrating equations at 5% levels. The existence of this co-integration implies that there is a long run equilibrium relationship existing between the variables in the equation. This is to say that if a set of variables are co-integrated, the effects of a shock to one variable spread to the others, possibly with time lags, so as to preserve a long run relationship between the variables. This goes in line with the works of Ogunlana and Lawal (2016) and Bada and Ogunbi (2017). Since variables are co-integrated, the VAR Granger causality is not necessary to check the direction of causality Granger (1969) and Megbowon (2016).

Table 2. Augmented Dickey Fuller Test of Unit root

Variables	Statistics	P-value	Implication	P-Value	Statistics	Implication
Price	-2.75841	0.2130	Non-Stationary at level	0.0000	-7.3330	Stationary at first difference
Production	-1.32748	0.8647	Non-Stationary at level	0.0030	-4.7282	Stationary at first difference
Area	-1.33886	0.8616	Non-Stationary at level	0.0093	-4.2723	Stationary at first difference
Exchange	-1.98669	0.5886	Non-Stationary at level	0.0006	-5.3297	Stationary at first difference
Export	-1.56287	0.9394	Non-Stationary at level	0.0000	-9.10793	Stationary at first difference
Import	-2.95521	0.1584	Non-Stationary at level	0.0000	-7.7447	Stationary at first difference
Inflation	-2.93418	0.1643	Non-Stationary at level	0.0000	-5.9490	Stationary at first difference
Population	-2.99625	0.1332	Non-Stationary at level	0.00947	-3.97456	Stationary at first difference
Budget	-2.29918	0.9273	Non-Stationary at level	0.0017	-4.4606	Stationary at first difference

Johansen co-integration test

Table 3. Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.999305	645.8510	159.5297	0.0000
At most 1 *	0.994054	398.6408	125.6154	0.0000
At most 2 *	0.939562	224.3919	95.75366	0.0000
At most 3 *	0.754270	128.9831	69.81889	0.0000
At most 4 *	0.730468	81.26335	47.85613	0.0000
At most 5 *	0.454494	36.68709	29.79707	0.0069
At most 6 *	0.341150	16.08165	15.49471	0.0408
At most 7	0.054206	1.894834	3.841466	0.1687

Trace test indicates 7 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4. Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.999305	247.2101	52.36261	0.0001
At most 1 *	0.994054	174.2489	46.23142	0.0000
At most 2 *	0.939562	95.40880	40.07757	0.0000
At most 3 *	0.754270	47.71979	33.87687	0.0006
At most 4 *	0.730468	44.57626	27.58434	0.0001
At most 5	0.454494	20.60544	21.13162	0.0591
At most 6	0.341150	14.18682	14.26460	0.0514
At most 7	0.054206	1.894834	3.841466	0.1687

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 5. Canonical co-integrating regression (CCR)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCHANGE	68.46215	115.8680	0.590863	0.5594
EXPORT	-1.050274	6.993875	-0.150171	0.8817
IMPORT	0.027892	0.117298	0.237785	0.8138
INFLATION	4.865600	126.5785	0.038439	0.0022
POP	0.903053	0.381534	2.366903	0.0251
PROD	-0.002583	0.002519	-1.025131	0.0041
BUDGET	-2.57E-07	2.08E-07	-1.236595	0.0965
C	-69539.71	28400.97	-2.448498	0.0209
R-squared	0.855364	Mean dependent var		24073.92
Adjusted R-squared	0.819205	S.D. dependent var		24355.79
S.E. of regression	10356.08	Sum squared resid		3.00E+09
Durbin-Watson stat	2.155388	Long-run variance		60249982

Dependent Variable: PRICE; Sample (adjusted): 1979-2014; Included observations: 36 after adjustments; Cointegrating equation deterministics: C = 4.0000)

The estimation results reveal that the explanatory variables jointly account for approximately 85.5 percent changes in maize price. The durbin-Watson statistic (2.16) illustrates the absence of auto correlation. The estimation results show that inflation, population and production quantity are statistically significant in explaining changes in maize price over the years. The coefficient of production quantity indicates that low production of maize will result in an increase in the price of maize, also a reduction in the budgetary allocation to agriculture could result in the increase in the prices of maize for that period. Also, the increase in the population of Nigeria tend to be associated with the cause of the increasing prices of maize over the years, this may be because of the effect of high demand and inadequate supply which will invariably result in the cobweb effect in the production cycle of maize over the years.

However, exchange rate, export and import are not significant in explaining the price change of maize over the years observed. The R^2 value 0.855364 implies that 85.55 percent total variation in Maize price is explained by the regression equation. Coincidentally, the goodness of fit of the regression remained close after adjusting for degree of freedom as indicated by the adjusted R^2 value of 0.819205 or 81.92%). Durbin Watson statistic 2.16 in the above table is found to be greater than R^2 value 0.855364 indicating that the model is not spurious. This is similar to the findings of Oyakhilomen and Zibah (2014) and Adom (2015).

Conclusion

One of the major points of this study is to determine the drivers of maize price variations in Nigeria for a period of 36 years. The maize price problem can be seen from the angle of high prices rise and the fluctuations from year to year. At the level of high food prices, maize price in Nigeria has exhibited historically high prices since 2008 and continued to worsen to date. Highly unstable prices of food can lead to inefficient agricultural production decisions, and have serious effects on the food security level of the country. The costs can be disastrous for the poor since food staples constitute a large share of smallholder farmers' incomes and poor consumers' expenditures. Several factors are linked to the maize price volatility problem ranging from natural to manmade. The co-integration test showed there is a long run relationship among the various variables considered in the study over the years. From the result obtained, the price of maize was found to be determined by inflation, population, agricultural budget and production quantity. Thus, it will be necessary for the government to take complementary actions to increase the budgetary allocations to agriculture in the country since it was discovered that a reduction in the budgetary allocation to agriculture could result in the increase in the prices of maize in Nigeria. The positive and significant impact of population to maize price change should serve as an impulse to encourage investments in the agricultural sector of Nigeria in order to ensure food security in the country. Overall, there is a need for a resilient and strong institutional development plan towards the continual production of maize and investment in its value chain due to its impact on the food security of the country.

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