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Factors Influencing the Prices of Rice, Maize and Wheat Prices in Nigeria

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Abstract

This study examines the impact of agricultural Gross Domestic Product (GDP) and imports on Nigeria's food commodity prices using annual data from 1981 to 2018. Data obtained were analysed using the unit root test, cointegration test and Autoregressive Distributed Lag (ARDL) model to evaluate the long-run and short-run effects of the hypothesized variables on the food commodity prices. The results reveal that maize import value and exchange rate significantly affect the price of maize in the short-run. In contrast, the lagged price of maize, maize output and the past value of maize imports are the factors that influenced the current price of maize within the review period. Also, the lagged price of rice, rice output and the lagged value of rice imported in the immediate year exerted significant influences on the price of rice in Nigeria. Furthermore, the study indicates that the lagged price of wheat, the import value of wheat and the lagged wheat import value were statistically significant in influencing wheat price in Nigeria. Hence, policies for flexibility in the harmonization of exchange rate movements strengthen domestic agricultural performance.

Keywords

ARDL, demand, exchange rate, food commodity price, import, supply.

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Introduction

The global food commodity price is a crucial variable in a market-oriented economy characterized by perfect information. Strategic and critical decisions are mostly taken based on the expected price at harvest, and farmers will be opened to better information opportunities to make the right decisions on future planting (Robert and Bergez, 2016). The volatile nature of agricultural commodity prices can be attributed to the low responsiveness of short term production and consumption (Haile et al., 2016; Brümmer et al., 2016). Planting decisions made by agricultural stakeholders before introducing new crop prices have caused a low production response to annual crop commodities output. However, these decisions are dependent on expected prices and not price realizations (FAO et al., 2020).

Albeit practically all the agricultural products experienced increased nominal prices, the pace of their increment from one commodity to another differed vehemently. Thus, there is a high surge in international prices of essential foods more than tropical commodities and raw materials. This relegates developing countries to be dependent on exports of major food commodities since their export earnings will be increasing sluggishly than the cost of food importations (Patel, 2012; Verter et al., 2020).

The selected food commodities for this study are maize, rice and wheat. These are Nigeria's essential food crops (staples) since they are known for high yield potential, storage value and wide range of use. Also, there is an increasing demand for these grains due to their importance as a raw material in producing animal feed for human consumption as food and beverage industries. First, however, some definite features give a general description of market price formation or these commodities. For example, there are annual production; long term storage; movement from farm to market in bulk form; and trading on commodity futures exchanges that facilitate hedging and forward contracting. In addition, they compete for the same cropland in production, resulting in the indirect linkage of their prices across markets (Schnepf, 2006; Chen et al., 2020).

Increased food production in Nigeria has not satisfied the demand owing to the population growth. This has led to food imports and low food self-sufficiency levels (Fasanya et al., 2018). As a result of the heavy importation of food, the increasing food prices are traceable to the influence of international food market prices. The recent surge in food prices experienced in 2020 due to twice the increase in petrol price led to food price inconsistency and volatility among commodity markets. This has wreaked substantive havoc on agribusiness, marketing system and environment, as well as the entire economy. Also, Nigeria categorized as a net food importer, reflecting on the recent increase in food price in 2019 – 2020 due to depreciation in Naira to USD

Considerable studies have been carried out on the factors influencing food commodity prices. For example, Ajibade et al. (2018) modelled the maize price and determinants using the Error Correction Model (ECM) approach. The study found that both short-run and long-run relationships exist between the significant variables and maize prices in Nigeria. In addition, some academic research (Gilbert, 2010; Wang et al., 2018) suggests an impact on price volatility from speculative activity, increasing demand, economic growth, countries' aggressive stockpiling policies, exchange rate, and trade restrictions.

This study looks at some macroeconomic factors that may have influenced food commodity prices in Nigeria. The study adopted an autoregressive distributive lag (ARDL) bound test (Pesaran et al., 2001; Narayan, 2005) to know if a long-run relationship exists between the variable of observations to circumvent the likelihood of biased and spurious estimations. Techniques like the two-step procedure (Engle-Granger, 1987) and completely modified OLS estimators (Phillips-Hansen, 1990) are responsible for committing when data utilization of restricted or limited for instance, when a sample is less than 80 (Pesaran et al., 2001; Narayan, 2005).

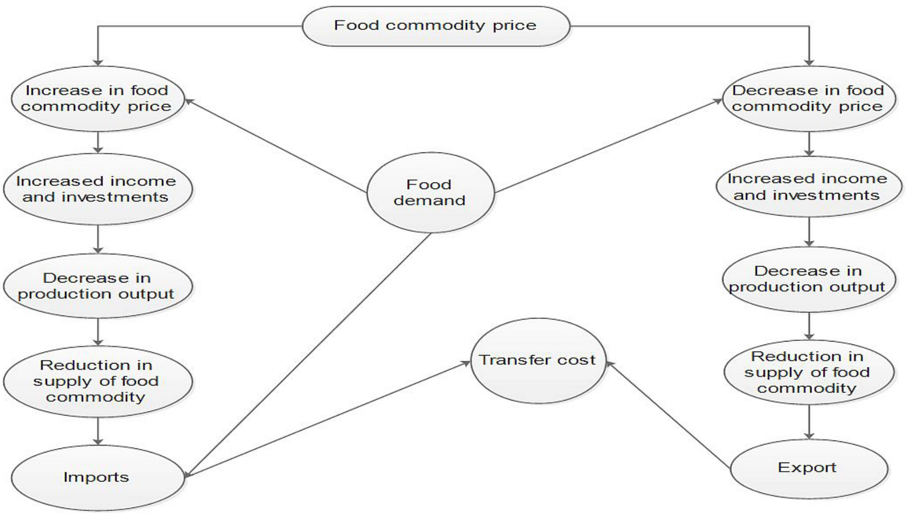
Conceptual framework

This section presents the conceptual linkages of the factors responsible for the price behaviour of agricultural commodities, as illustrated in Figure 1. Price is the fulcrum of agreement between buyers (demand) and sellers (supply) in the marketplace. The adjustments of different prices to their speed and efficiency rely on the market structure where the commodities are traded (Schnepf, 2006). Various market forces have compromised the global price level of food commodities and can alter both the current or future balances between supply and demand. These factors are food demand for human consumption, feed demand for animal use and industrial-use market demand for industries. Others include; government policies, factors influencing production processes; products' storage and transportation factors; and relative prices of substitute crops for production or consumption.

Also, the intensity of counties' engagement in international trade is a crucial factor. The differential outcome in the prices globally has a significant ripple effect on the differences in local supply and demand conditions. A complex web of local supply and demand situations (transfer cost) decides how and when commodities move through this network in international trade interaction. Price changes at any point along the chain can shift to alternate transport modes or routes as marketers search for the lowest-cost method of moving the food commodities between buyer and seller (Figure 1).

Food importation is predominant among many developing economies, and this phenomenon never ceases to decline at any instance. These countries majorly depend on huge supplies of agricultural commodities at lower costs in the global markets due to the intervention of developed economies/countries in providing subventions for production and trade. At any reduction in this support, commodity prices are expected to spike, thereby presenting exorbitant import bills for the vulnerable economies that heavily depend on food importations (FAO et al., 2019).

Some countries have abundant natural resources, but their agriculture sectors are unable to satisfy domestic food demand. Most of these countries adopt tariffs and border protection measures targeted at increasing domestic agricultural prices and providing subventions for agricultural growth and development (FAO et al., 2020). However, these countries have enacted policies that protect their producers while investing in improving productivity and technologies. A portion of these cost increments can be attributed to the depreciation of the US dollar



Source: Authors' Illustration

Figure 1: Conceptual framework for agricultural commodity price.

(USD), which dominates international prices. It has, therefore, complicated to relate the currency and commodity prices when assessing spikes in prices of agricultural commodities (Ogunmola et al., 2017). Likewise, it can be linked to the implications of how the changes influence various nations. In most developing countries, the gravity of increment in global market prices mirrors how dependent the local consumer and producer prices are on their USD exchange rate and other import variables (infrastructure, market structures and tariffs) (FAO et al., 2020). This study aimed to investigate the impact of agricultural gross domestic product (agricultural GDP) and imports on rice, maize, and wheat prices in Nigeria for 1981-2018.

Materials and methods

The study used yearly time series data for the producer price of food commodities (maize, rice, and wheat) expressed in Nigerian currency (the naira per metric tonne), the production output of these food commodities (metric tons), importation value (metric tons), agricultural GDP (2012 constant price), and exchange rate (annual USD/Naira value) from 1981 to 2018. The data for the study was obtained from the Food and Agriculture Organisation of the United Nations (FAO, 2020), the National Bureau of Statistics (NBS, 2020), and the Central Bank of Nigeria (CBN, 2020). The precise motive for yearly frequency data was the non-availability of updated monthly data set for some series, hence annual data set uniformity.

Empirical Model: ARDL Bounds Tests for Cointegration

After establishing that the variables have a combination of level (I(0)) and first differencing (I(1)), the ARDL bounds testing technique (Pesaran et al., 2001) was adopted to estimate the relationship between the variables.

Cointegration serves as a powerful tool in ascertaining the occurrence of long-run interactions or equilibrium between variables (Nkoro and Uko, 2016). Many cointegration methods have been developed to empirically analyse the long-run relationships between time series, such as the residual-based technique (Engle and Granger, 1987) and the maximum likelihood test (Johansen and Juselius, 1990; Johansen, 1991). However, these methods restricted all series in consideration to be integrated of the same order. ARDL, a cointegration approach, was developed (Pesaran et al., 2001).

The ARDL method can be applied when the variables of interest are integrated of order zero (I(0)), order one (I(1)) or a mixture of both. This approach is more efficient for validating cointegrating relationships with small and finite sample sizes. Also, the ARDL method allows the time series to have different optimal lags. With the use of a single reduced form equation, it will enable the estimation of unbiased long run and short-run parameters of the model.

The ARDL model estimated for this study was specified as follows:

$$\Delta lnFP_t^{maize} = \alpha_0 + \varphi_1 lnFP_{t-1}^{maize} + \varphi_2 lnPD_{t-1}^{maize} + \\ + \varphi_3 lnIMP_{t-1}^{maize} + \varphi_4 lnY_{t-1} + \varphi_5 REXH_{t-1} + \\ + \sum_{i=1}^{p} \tau_i \, lnFP_{t-i}^{maize} + \sum_{i=1}^{p} \omega_i \, \Delta lnPD_{t-i}^{maize} + \\ + \sum_{i=1}^{p} \delta_i \, \Delta lnIMP_{t-i}^{maize} + \sum_{i=1}^{p} \vartheta_i \, \Delta lnY_{t-i} + \\ + \sum_{i=1}^{p} \psi_i \, \Delta REXH_{t-i} + \varepsilon_t \quad (1)$$

$$\Delta lnFP_t^{rice} = \alpha_0 + \varphi_1 lnFP_{t-1}^{rice} + \varphi_2 lnPD_{t-1}^{rice} + \\ + \varphi_3 lnIMP_{t-1}^{rice} + \varphi_4 lnY_{t-1} + \varphi_5 REXH_{t-1} + \\ + \sum_{i=1}^{p} \tau_i \, lnFP_{t-i}^{rice} + \sum_{i=1}^{p} \omega_i \, \Delta lnPD_{t-i}^{rice} + \\ + \sum_{i=1}^{p} \delta_i \, \Delta lnIMP_{t-i}^{rice} + \sum_{i=1}^{p} \vartheta_i \, \Delta lnY_{t-i} + \\ + \sum_{i=1}^{p} \psi_i \, \Delta REXH_{t-i} + \varepsilon_t \quad (2)$$

$$\Delta lnFP_t^{wheat} = \alpha_0 + \varphi_1 lnFP_{t-1}^{wheat} + \varphi_2 lnPD_{t-1}^{wheat} + \\ + \varphi_3 lnIMP_{t-1}^{wheat} + \varphi_4 lnY_{t-1} + \varphi_5 REXH_{t-1} + \\ + \sum_{i=1}^{p} \tau_i \, lnFP_{t-i}^{wheat} + \sum_{i=1}^{p} \omega_i \, \Delta lnPD_{t-i}^{wheat} + \\ + \sum_{i=1}^{p} \delta_i \, \Delta lnIMP_{t-i}^{wheat} + \sum_{i=1}^{p} \vartheta_i \, \Delta lnY_{t-i} + \\ + \sum_{i=1}^{p} \psi_i \, \Delta REXH_{t-i} + \varepsilon_t \quad (3)$$

where Δ = change operator; *ln* = natural logarithm; p = 2 (number of lags used guided by Akaike Information Criterion); FP_t^{maize}, FP_t^{rice}, and FP_t^{wheat} = prices per metric tons for maize, rice and wheat, respectively; PD_t^{maize}, PD_t^{rice}, and PD_t^{wheat} = production output for maize, rice and wheat, respectively; IMP_t^{maize}, IMP_{trice}, and IMP_t^{wheat} = values of importation for maize, rice and wheat, respectively; Y_t = Agricultural Gross Domestic Product proxy for agricultural income; *REXH* = effective exchange rate in Nigeria; α_0, φ_1, φ_2, φ_3, φ_4, φ_5, τ_i, ω_i, δ_i, ϑ_i, and ψ_i are the parameters estimate; and ε_t = error term of the regression.

The ARDL bounds test was used to test the null hypothesis that no cointegration exists against the alternative hypothesis that cointegration exists. The null hypothesis is defined as H_0: $\varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = \varphi_5 = 0$. The test is based on F-statistics and compared with the critical values developed by Narayan (2005) because of its suitability for a small sample size. If the value of the com-puted F-statistic is greater than the upper bound (I(1)), the stated null hypothesis of no cointegration will be rejected. If the computed value of F-statistic is less than the lower bound (I(0)), we will fail to reject the null hypothesis that no cointegration exists. Furthermore, if the value of F-statistic is found between I(0) and I(1), the test would be inconclusive.

Long-run and short-run functions

Having estimated the ARDL bounds test to establish the long-run relationships among the observed series, there is a need to specify and estimate the long-run (LR) and short-run (SR) functions for the equation that rejected the null hypothesis of no cointegration between the series. As proven (Table III), the bounds test for equation 1 reveals a long-run relationship among the observed variables, requiring LR and SR estimations.

Long-run supply function

The equation for long-run supply response is presented thus:

$$lnFP_t^{maize} = \beta_0 + \phi_1 lnFP_t^{maize} + \phi_2 lnPD_t^{maize} + \\ + \phi_3 lnIMP_t^{maize} + \gamma_1 lnY_t + \gamma_2 REXH_t + u_t \quad (3)$$

where *ln* = natural logarithm; FP_t^{maize} = price per metric tons for maize; PD_t^{maize} = production output for maize; IMP_t^{maize} = value of importation for maize; Y_t = Agricultural GDP proxy for agricultural income; *REXH* = real effective exchange rate in Nigeria; β_0, ϕ_i, and γ_i = parameters to be estimated; and μ_t = random error of the regression.

Short-run supply function

We described the short-run dynamics of the observed variables by adopting ECM (Lütkephol, 2005). The ECM is specified as follows:

$$\Delta lnFP_t^{maize} = \sigma_0 + \sum_{i=1}^{p} \rho_i \, lnFP_{t-i}^{maize} + \sum_{i=1}^{p} \ell_i \, \Delta lnPD_{t-i}^{maize} + \\ + \sum_{i=1}^{p} \lambda_i \, \Delta lnIMP_{t-i}^{maize} + \sum_{i=1}^{p} \gamma_1 \, \Delta lnY_{t-i} + \\ + \sum_{i=1}^{p} \gamma_2 \, \Delta REXH_{t-i} + \lambda ECM_{t-1} + \xi_t \quad (5)$$

where $ECM_{t-1} = \hat{u}_{t-1}$ which is the error correction or cointegration term (it is equivalent to the lagged value of the error term in equation (4)); p = 1 and is the number of lagged used (according to AIC, maximum of one lag is expected to catch up with the most recognized dynamic adjustment in the series); l_i, and λ_i = short-run price elasticities; γ = impact of income and real exchange rate on the short-run maize price; ξ_t = regression error term; λ = coefficient ECM and is "the speed of adjustment of a parameter presenting how speedily the series can return to its long-run equilibrium position". The sign of the coefficient must be negative and significant (Dube et al., 2018).

Some diagnostic tests (Durbin Watson and Breush-Godfrey Serial Correlation LM test, Jarque-Bera statistics for error normality (JB), the ARCH statistics for autoregressive conditional heteroskedasticity, skewness and kurtosis) were estimated to guarantee the acceptability of the model. The cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ) were tested on the series to assess the coefficients' stability.

Results and discussion

Table 1 shows a description of the variables considered for this study. The minimum and maximum values reflect the range of the variables change to agricultural production and prices, reflect the data trend, and reflect the centre value of the data trend. The mean values of the variables express a striking pattern and have reasonable returns due to their positive nature over the period. It reflects the degree to which the data distribution aggregates to its centre value. Shreds of evidence show that the standard deviation of the series demonstrates the degree of dispersion and the stability of these data sets.

The more significant deviation of maize, rice and wheat outputs indicates that the food commodities' outputs fluctuate widely, indicating that the production outputs are enormous over the years considered for the study. Furthermore, the result shows that all the variables are positively skewed except maize output with negative skewness. This implies that the positively skewed variables/series have an asymmetric distribution with a long right tail, while maize output has a left tail (Table 1).

The kurtosis indicates that only import values of maize exhibit leptokurtic showing the heavy outliers in the series. Rice and wheat production output show mesokurtic distribution, showing that the variables follow a normal distribution while other series are platykurtic or follows a subtle/pale curve. The curves signify the small number of outliers in the distribution, and there is a lesser probability of producing extreme returns. Overall, according to JB outcome, the series (the commodity prices, production outputs, importation values, income, and exchange rate) are not normally distributed and follow a fluctuation pattern suggesting instability (Table 1).

Time series unit root test

Most monetary or economic time series are non-stationary and, therefore, crucial to investigate the unit root and cointegrated relationship (Adeoye et al., 2014). The ARDL bounds test assumes that the variables are I(0) or I(1). Before applying this test, integrating all variables must be determined using the unit root tests estimation. This is to certify that the observed variables are not I(2) to circumvent

Variable	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	JB
Maize prices	30127.26	82452	210	26735.93	0.286	1.605	3.601
Rice prices	33566.29	76261	400	27110.09	0.180	1.561	3.483
Wheat prices	32824.82	80500	280	25631.10	0.083	1.646	2.948
Maize output	6012688	11547980	720000	2731918	-0.103	2.764	0.155
Rice output	3472398	7564050	1241000	1621392	0.750	3.083	3.569
Wheat output	67966.45	165000	26000	32763.05	1.059	3.816	8.159
Maize import	12240.08	132314	0	26668.07	2.969	12.439	196.92
Rice import	473608.5	1167406	94478	323064.30	0.523	1.913	3.604
Wheat import	619411.9	1589017	8469	460053.20	0.366	1.819	3.056
Income	7693.52	17544.15	2303.51	5159.29	0.611	1.837	4.502
Exchange rate	88.54	306.08	0.62	87.14	0.803	2.974	4.085

Source: Authors' calculations (2020)

Table 1: Descriptive statistics of the variables.

spurious results. If the variables are integrated into order two, Pesaran et al. (2001)'s F-statistics will be inappropriate and not be interpreted. To ascertain robustness in the model, the Augmented Dickey-Fuller (ADF) test and two other advanced unit root tests (Dickey-Fuller Generalized Least Squares (ADF-GLS) test and Ng–Perron (Ng-P) test) were employed because of their strength to produce reliable results for small sample data sets and power.

The unit root test results on the modelled variables are shown in Table 2 based on constant and no deterministic trends of Akaike information criteria (AIC) for the optimal lag order. The ADF statistics at the level explained the non-stationary nature of all variables. However, they became stationary when subjected to first differencing. Dickey-Fuller GLS showed that series (variables) are stationary at first difference except for wheat output stationary at the level I(0). The Ng-Perron test reveals that all the variables became stationary after first differencing. This confirmed that they were all generated by the same stochastic processes and exhibited long run spatial equilibrium. Since the tests indicate none of the variables is I(2), there is a need to proceed to the bounds testing procedure.

Cointegration tests

The existence of cointegration among the series used for this study was verified by adopting the bound test for cointegration approach with unrestricted constant and no trend. The test was carried from the three equations with the commodity prices (maize price, rice price and wheat price) being the dependent variables. The results in Table 3 show that the calculated F-statistic (6.183) and t-statistics (-4.893) when maize price is the dependent variable rejected the null hypothesis, establishing a long-run relationship between the series. It means cointegration exists among the modelled variables. Thus, cointegration among the variables helps analyse the short-run and long-run relationship of the dynamics influencing maize prices in Nigeria.

When rice price is the dependent variable, F-statistics (3.504) and t-statistics (-2.941) values cannot reject the null hypothesis, indicating the non-existence of a long-run relationship among observed variables. Also, there is no long-run relationship

Variables	Form	ADF	ADF GLS	Ng-Perron
Maize price	Level	-3.320	-0.820	-7.802
	First difference	-7.705	-7.502	-16.997
Rice price	Level	-3.471	-0.222	0.443
	First difference	-6.932	-6.718	-17.679
Wheat price	Level	-2.630	-0.653	-0.462
	First difference	-3.855	-3.775	-14.75
Maize output	Level	-3.796	-0.489	0.392
	First difference	-3.687	-3.736	-14.734
Rice output	Level	-1.141	0.310	1.104
	First difference	-9.455	-9.424	-14.594
Wheat output	Level	-3.637	-2.207	-7.083
	First difference	-5.587	-5.758	-10.011
Maize import	Level	-1.189	-0.886	-1.825
	First difference	-5.218	-5.304	-1268.27
Rice import	Level	-0.430	-0.913	-2.091
	First difference	-8.444	-3.141	-8.321
Wheat import	Level	-12.712	-1.097	-3.089
	First difference	-6.655	-2.334	-1.570
Income	Level	0.024	0.675	1.158
	First difference	-5.851	-5.758	-17.964
Exchange rate	Level	1.737	0.544	1.929
	First difference	-4.211	-4.141	-15.856

Note: Critical Value (CV) for ADF = -2.951, ADF-GLS = -1.952 and Ng-Perron = -8.10
Source: Authors' computation (2020)

Table 2: Unit root test result of the series.

Variable	Statistics	10%		5%		1%		p-value		Cointegration
Level		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
Maize price	F = 6.183	2.639	4.138	3.278	5.031	4.896	7.274	0.003	0.021	Yes
	t = -4.893	-2.437	-3.572	-2.835	-4.045	-3.665	-5.035	0.001	0.013	
Rice price	F = 3.504	2.674	3.966	3.265	4.742	4.702	6.613	0.038	0.151	No
	t = -2.941	-2.525	-3.64	-2.89	-4.068	-3.642	-4.946	0.045	0.257	
Wheat price	F = 3.136	2.691	3.933	3.275	4.686	4.684	6.486	0.059	0.206	No
	t = -2.531	-2.549	-3.659	-2.907	-4.079	-3.642	-4.933	0.103	0.409	

Source: Authors' computation (2020)

Table 3: Bounds test for cointegration: unrestricted constant and no trend (k=4; N=34).

amongst the variables when the wheat price is the dependent variable as the F-statistic (3.136), and t-statistics (-2.531) values cannot reject the null hypothesis of no cointegration among the variables (Table 3). This aids the ARDL framework's choice to analyse only the short-run relationship between rice and wheat prices in Nigeria.

Factors affecting the food commodity price

Using Akaike Information Criterion (AIC), ARDL (4 3 3 1 1) reveal to be the best model for the series when maize price is the dependent variable, ARDL (2 2 1 0 0) was used when rice price is the dependent variable while ARDL (2 0 1 0 0) was the best when the wheat price was the dependent variable. Table 4 presents the model estimation of the short-run and long-run relationship among commodity prices and the hypothesized variables (ECM) when the maize price is the dependent variable. Similarly, Tables 5 - 6 present the ARDL model estimation when rice and wheat prices are dependent on the variables. Before drawing inferences, various diagnostic statistics test was conducted to judge the adequacy of the dynamic specification.

According to diagnostics testing, the three models indicate no autocorrelation problem based on the Durbin-Watson statistic test. Furthermore, the Breusch-Godfrey Serial Correlation LM Test results show no serial autocorrelation problem in the specified models. Also, there was no problem of heteroscedasticity signifying the validity of the specified models and that the models were fit for cointegration analysis. Finally, the stability test results of the CUSUM and CUSUMQ indicated a correctly specified and stable model.

Parameters long-run and short-run estimation of maize price model

Long-run estimation

The parameter estimates for the long-run maize price function are presented in Table 4. Evidence from the result revealed that maize price was swiftly responsive to its import value and exchange rate consistent with trade theories. Specifically, the result indicates that a 1% movement (upswing) in maize import value results in about 0.91% increases in the price of maize. This implies that importing more maize may accumulate foreign debt thereby escalating positive food price shocks. Furthermore, a decline in consumption, increasing poverty and government expenditure, and borrowing show positive food price shocks, thus worsening food security (Meerman and Aphane, 2012).

The partial elasticity of maize price to the change in the exchange rate exhibits a positive and significant relationship at a 1% probability level (Table 4). This shows that a 1% increase in the long-run exchange rate coefficient significantly increased the maize price by about 0.03% in Nigeria. In Nigeria, the maize price may increase as the exchange rate can make maize export more lucrative and attractive, thereby posing competition between domestic availability and maize exportation. In tandem with Ajibade et al. (2018) findings, the annual exchange rate positively influenced Nigeria's maize prices. This is a sign that certain economic variables may influence food prices. The results emphasize the policy relevance that the exchange rate affects the commodity prices' performance via its volatility and depreciates or appreciated value. Depreciation in the local currency's value makes the product prices cheaper such that more revenue will be obtained.

Short-run estimation

The ECM was estimated to determine the series' short-run dynamics in the specified model. Table 4 presents the evidence of short-run relationships existing amongst the residuals of the specified series included in the model of the equation. The ECM (ECMt-1) coefficient was negative and significant. This establishes the occurrence of cointegration among the modelled variables for the study.

Variable	Coefficient	Std. Err	t	P>|t|
Long-Run Equation				
Maize Output	0.756	0.545	1.39	0.183
Maize Import Value	0.910***	0.222	4.09	0.001
Income	1.486	3.252	0.46	0.654
Exchange rate	0.031**	0.011	2.84	0.011
Short-Run Equation				
Δ(Maise Price)$_{t-1}$	-0.649***	0.170	-3.82	0.001
Δ(Maise Price)$_{t-2}$	-0.585***	0.167	-3.49	0.003
Δ(Maise Price)$_{t-3}$	-0.210	0.175	-1.2	0.248
Δ(Maize Output)	-1.072**	0.435	-2.46	0.025
Δ(Maise Output)$_{t-1}$	-1.071**	0.412	-2.6	0.019
Δ(Maise Output)$_{t-2}$	0.378	0.401	0.94	0.360
ΔMaize Import Value	-0.242***	0.065	-3.71	0.002
Δ(Maise Import Value)$_{t-1}$	-0.165***	0.042	-3.9	0.001
Δ(Maise Import Value)$_{t-2}$	-0.070**	0.023	-3	0.008
Δ(Income)	-0.160	0.691	-0.23	0.820
Δ(Exchange rate)	0.004	0.004	1.24	0.233
(ECM)$_{t-1}$	-0.349***	0.071	-4.89	0.000
Constant	-0.218	3.051	-0.07	0.944
R-squared	0.7973		Adj R-sqd	0.6064
Log-likelihood	10.6304			
Number of obs	34			
Diagnostics tests				
DW	1.828			
LM	0.047	p-value	0.8278	
Heteroskedasticity	34	p-value	0.4192	
Skewness	22.37	p-value	0.1317	
Kurtosis	0.55	p-value	0.4575	
J-B	1.784	p-value	0.4098	

Note: *, **, *** Significance level at 1%, 5% and 10% respectively; DW = Durbin-Watson;
LM = Breusch-Godfrey LM test for autocorrelation; JB = Jarque-Bera normality test
Source: Authors' computation (2020)

Table 4: The estimated coefficient of maize price.

The Error Correction term (ECTt-1) coefficient, representing the speed of adjustment for both estimators, is significantly different from zero with an expected negative sign. The error correction coefficient for the model was -0.349, which reveals a fast convergence to equilibrium immediately adjusted by the differenced terms in each period. Therefore, this result confirms a steady relationship among the variables established in the equation. It may be recognised that the current maize price-sensitive to its deviation from equilibrium during the past period. When there are no variations among the hypothesised series (exogenous variables), the model tends to correct its deviation from the long-run relationship by a 34.9% increase in the future price of maize.

The regression result shows that in the short run, the first and second lags of maize price, maize output, first lag of maize output, maize import value and the lags (first and second) of maize import value were the significant variables hypothesized to influence the price of maize within the reviewed period in Nigeria. The partial elasticity of the first and second lags of maize price was -0.649 and -0.585, respectively and statistically significant at a 1% significance level. This implies that a 1% increase in maize prices in the previous years will cause a decrease in the current price of maize by 0.65% (one lag) and 0.59% (two lags). The result agrees with Eldukhey et al. (2010) that the past or previous prices of grains yield a decrease in the current price.

Evidence from Table 4 reveals that a one-unit increase in maize output results in a 1.072 unit decrease in maize price. Also, the lag of maize output has a considerable influence on the price movement of maize. This is consistent with standard production theory and expected since an increase in production results in overwhelming supply that suppresses the efficacy of demand resulting in price fall needed to rejuvenate the market equilibrium. This result is in tandem with Ajibade et al. (2018), which shows that an increase in maize output decreased its price in Nigeria. The import value of maize is another essential and significant variable that affects maize price performance in Nigeria. Its partial elasticity was 0.242 in the short-run, implying that a unit increase in the maize imported within the reviewed year might decrease Nigeria's maize price by 0.242 units.

It is also observed that the earlier import value of maize (both the first and second lags) significantly influenced the price movement of maize in the country. Both have a negative relationship with the price of maize. This is expected since the importation of maize will increase the quantity of the commodity available for consumption and use (Table 4). According to supply theory, the increase in maize production will invariably decrease maize price. The result contrasts Ogundari (2016) that an increase in maize supply significantly increases maize price.

Parameters estimation of rice price model

Having established the cointegration existing among the series, we estimate the ARDL long-run model for rice price with the ARDL (2 2 1 0 0) specification. The results obtained for the factors influencing rice price in the long-run are reported in Table 5. The results indicate that three variables, price of rice (first and second lags), rice output, and the lagged value of rice imported in the immediate year significantly affected rice price in Nigeria over the reviewed period. In the past years (first and second lags), the lagged rice price values coefficients are 0.641 and 0.269 in Nigeria, statistically significant at 1% and 10%, respectively. The implication is that if there is a 1% increase in rice lagged price in the past years (first and second lags), rice's current price increased by 0.64% and 0.27%. The finding agrees with Hermawan et al. (2017) that rice's lagged value significantly affects rice's current price in the market.

Speculations about rice's previous price might

Variable	**Coefficient**	**Std. Err**	**P>|t|**
Constant	0.995***	0.305	0.003
$(\text{Rice Price})_{t-1}$	0.641***	0.159	0.000
$(\text{Rice Price})_{t-2}$	0.269*	0.150	0.085
Rice Output	0.695**	0.317	0.038
$(\text{Rice Output})_{t-1}$	0.589	0.354	0.109
$(\text{Rice Output})_{t-2}$	0.403	0.313	0.210
Rice Import Value	0.078	0.159	0.628
$(\text{Rice Import Value})_{t-1}$	0.387**	0.167	0.029
Income	-0.025	0.622	0.969
Exchange rate	-0.003	0.003	0.222
F(9, 25)	133.51***	Prob>F	
R-squared	0.9796	Adj R-sqd	
Log-likelihood	5.3413		
Number of obs	35		
Diagnostics tests			
DW	2.217		
LM	1.734	p-value	
Heteroskedasticity	36	p-value	
Skewness	6.39	p-value	
Kurtosis	1.63	p-value	
JB	21.03	p-value	

Note: *, **, *** significance level at 1%, 5% and 10%, respectively; DW = Durbin-Watson d-statistic (10, 36); LM = Breusch-Godfrey LM test for autocorrelation;
JB = Jarque-Bera normality test
Source: Authors' computation (2020)

Table 5: Estimated coefficient for rice price.

determine the current price, especially in nations with weak commodity price regulations. The rice output also positively affected its price in the country with a coefficient of 0.695 ($p < 0.05$), implying that a percentage increase in rice output would increase the product's price by 0,70 % The latter result underscores the relevance of rice production in Nigeria. It becomes evident that in Nigeria, increases in rice production led to a rise in the price of the food commodity because the rise in population drives the increase in total demand for rice. However, rice demand is being met through imports, increasing rice prices. The lagged value of rice imported in the immediate year positively influenced the price of rice. On average, the rice price increased by 0.387 units in the previous year. This implies that the import value changes in some sectors due to rice price increase show that domestic production cannot meet domestic needs (Table 5). This result is in resonance with the outcomes of Suryadi et al. (2014) increased import value of rice has a positive impact on the price of rice. It is said that Indonesia was importing all commodities in a colossal amount. However, the import of other services and industries tends to decrease because the decrease is minimal by the increase in rice price.

Parameters estimation of wheat price model

Table 6 shows the coefficients of the variables influencing the price of wheat. The results show that the lagged price (first and second lags) of wheat and its import value and the lagged value of wheat import (wheat import value in the immediate past year) were statistically significant in influencing wheat price in Nigeria. The coefficients of the lagged value of wheat price in the past years (first and second lags) are 0.432 and -0.736, respectively and are significant at 5% and 10% levels of significance, respectively. This implies that a 1% increase in the lagged wheat price will increase wheat's current price by 0,43% in the immediate past years. In contrast, the lagged wheat price will decrease the current wheat price by 0.74 % in the past two years. Thus, the result agrees with Enghiad et al. (2017) that the lagged wheat prices were found among the factors affecting wheat prices.

The import value of wheat exerted a significant and negative effect on the price of wheat at a 1% level of significance. Its coefficient was 0.31, implying that a unit increase in the wheat imported within the reviewed year will decrease its wheat

Variable	**Coefficient**	**Std. Err**	**P>|t|**
Constant	3.209**	2.56	0.017
$(\text{Wheat Price})_{t-1}$	0.432**	3.04	0.006
$(\text{Wheat Price})_{t-2}$	-0.736***	-4.80	0.000
Wheat Output	-0.098	-0.94	0.358
Wheat Import Value	-0.310***	-4.83	0.000
$(\text{Wheat Import Value})_{t-1}$	0.165**	2.69	0.013
Income	-0.771	-1.60	0.121
Exchange rate	0.001	0.47	0.644
F(7, 25)	7.62***	0.0001	0.969
R-squared	0.6808	0.5914	0.222
Log-likelihood	11.7634		
Number of obs	33		
Diagnostics tests			
DW	2.172		
LM	1.309	0.2525	
Heteroskedasticity	36	0.4215	
Skewness	6.99	0.4303	
Kurtosis	1.14	0.2859	
JB	16.62	0.0000	

Note: *, **, *** significance level at 1, 5 and 10% respectively; DW = Durbin-Watson d-statistic (10, 36); LM = Breusch-Godfrey LM test for autocorrelation; JB = Jarque-Bera normality test

Source: Authors' computation (2020)

Table 6: Estimated coefficients for wheat price.

price by 0.31 units. The lagged wheat import value in the immediate past year (first lag) equally exerted a significant but positive effect on wheat's current price in Nigeria (Table 6). The finding agreed with Enghiad et al. (2017) that the importation of wheat is one factor that significantly affects the price of wheat. In Nigeria, there is an increase in wheat flour-based products, which results in heavy wheat demand. There is a need for the country to increase wheat imports to satisfy the market even in high tariffs and exchange rates, thereby influencing the commodity's price behaviour.

Conclusion

This study analyses the implication of agricultural production and importation on food commodity prices in Nigeria using the time series data for 1981–2018. The ARDL bound test approach proposed by Pesaran et al. (2001) was adopted to analyse the cointegration between selected food commodity prices and hypothesized variables. It was established that the variables under study were all stable after first differencing that led to further econometric testing. According to the bound test for cointegration, both short-run and long-run relationships exist among Nigeria's determinants of maize price. Simultaneously, there was no evidence of long-run relationships among the modelled variables for both rice and wheat prices' equations. The diagnostics test conducted certified the model to be statistically fit for estimation.

Application of ECM form of the ARDL approach for maize price model shows that the error correction coefficient, which determines the speed of adjustment, has an expected and highly significant negative sign. The results show that maize import value and exchange rate significantly affect maize's price in the short-run. In contrast, lagged prices (first and second lags) of maize, maize output (and the lagged value of maize output), and the past value of maize imports are the factors that influenced the current price of maize within the review period. Also, the price of rice (first and second lags) and the lagged value of rice imported in the immediate year exerted significant influences on the price of rice in Nigeria. The study indicates that the lagged price (first and second lags) of wheat, wheat import value, and the lagged value of wheat import (wheat import value in the immediate past year) were statistically significant in influencing wheat price in Nigeria.

The ARDL model showed that shock in the exchange rate has high transmission effect on maize price. Intuitively, the accessibility to fund by the producers is determined by the lending rate and exchange rate has great effect on food prices, due to the high importation of agricultural raw material and agricultural product (net importer of food). Market intervention and price fixing policy could be the main impediments to exchange rate in Nigeria. Commodities' price setting and marketing policies aimed at price stability preclude exchange rate effects domestic producer prices. These measures can also insulate the nation's principal source of foreign exchange from instability in the world market.

Also, the responses of rice and wheat prices to their lagged values is significant and positive. The estimated prices though not high, point to the fact that price policy can still partly be used to increase maize and wheat production in Nigeria. This implies that if government must reduce the future price of these commodities, significant measures need to be implemented. The government can subsidize the inputs to enhance production growth and in the long run impose importation tariff to encourage purchase of own produced commodities. This would help in mitigating the effects of rising prices challenge faced by rice and wheat farmers.

It could be concluded that the price of these food commodities has been on the increase over the years which resonates the global surge in the market prices. Due to the unpredictable movement in food prices, the government should ensure the provision of soft agricultural credit scheme to farmers with a low lending rate through Cooperative and Rural Development Banks so as to encourage small holder farmers to increase agricultural production and to overcome the threat of food insecurity in the country.

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