



RESEARCH ARTICLE

Trend Analysis and Macroeconomic Variable Determinants of Egg Production in Nigeria

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ABSTRACT

The daily animal protein intake of an average Nigerian is far less than the World Health Organization recommended minimum standard. The egg is the cheapest and most affordable animal protein source in Nigeria, but its production has not been able to match the increasing demand capacity. Premised on the above facts and to identify ways to intensify egg production, the study was specifically designed to examine the trend in egg production and establish the relationship between egg production and selected macroeconomic fundamentals in addition to other variables in Nigeria. The study used time series data from the period 1961 to 2020. The data were sourced from the Food and Agricultural Organization (FAO), the World Bank, and the Central Bank of Nigeria. The Augmented Dickey-Fuller unit root test and ADF-GLS unit root test were used to confirm the stability of the series. The Engle-Granger two-step technique was used to test for the cointegration of the series. The empirical finding showed that the amount of credit disbursed to the agricultural sector, per capita income, and the quantity of maize and chicken meat produced are positive determinants of egg production in both long and short-run periods. In contrast, the consumer price index (inflation rate) relates negatively in both periods to egg production. To upsurge egg production in the country, it is recommended that more credit facilities be injected into the agricultural sector. At the same time, the inflation rate is maintained at a minimal rate in the country.

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Introduction

Egg production in Nigeria has a long history and is now an important component of the poultry sub-sector, constituting about 30% of the total poultry production (Esiobu et al., 2014). The supply and demand for eggs in the country have witnessed a tremendous improvement over the years (FAO, 2022; see Table 1). Several reasons are accounted for by the country's expanding production and utilization of poultry eggs. The case for the mounting population with the corresponding increase in demand capacity for egg products is obvious. Besides, the difficulties and security challenges encountered during the production and transportation of other animal sources of

protein, such as goats, cows, sheep, and pigs across regions in the country, have additionally stirred interest in egg production as an efficient alternative and more reliable source of animal protein. Furthermore, egg production is an integral part of many youth empowerment programmes across the country, perhaps because of its sustainable nature (Ajani et al., 2015; Price, 2019; UNDP, 2020; Ajala et al., 2021). Moreover, the egg being the cheapest source of animal protein, is found almost everywhere in the country, which further exaggerates intensified production. Subsequently, several home-based poultry farms have metamorphosed into small-to-medium-sized commercially viable poultry farms across the country (Netherlands Enterprise Agency, 2020). According to FAO

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(2021), the bulk of the poultry (80%) is produced by rural households in developing societies, hence constituting a sustainable source of livelihood activity. In Nigeria, egg production has supported the livelihood activities of more than 10 million rural and urban households. Additionally, about

16.80% of the country's population (representing over 33.6 million people) is in the age range of 15 and 35 years and is regarded as youth. According to analysts, a youthful population incentivises production (Adeniran et al., 2018; Nmeragini et al., 2020; Ajala et al., 2021).

Table 1. The contribution of the livestock sub-unit to the agricultural sector and economy and the per capita egg consumption in Nigeria.

Policy Year	Average Livestock Contribution to Agricultural GDP (%)	Average Livestock Contribution to Economy GDP (%)	Average Per Capita Consumption of Egg (Number of Egg/Person)
1981-1985	19.808	3.019	70.68
1986-1990	15.205	3.085	74.08
1991-1995	12.406	2.897	94.49
1996-2000	11.779	3.204	72.88
2001-2005	7.847	2.323	78.30
2006-2010	7.483	1.916	85.44
2011-2015	8.363	1.778	85.99
2016-2021	7.036	1.557	82.72
1981-2020	11.138	2.450	72.43

Source: Computed by authors. Gross domestic product at the current basic prices (₦ Billion).

The commercial egg industry in Nigeria consists mainly of eggs from hens. The local production only meets 19.84% of the domestic demand (following the American Heart Association recommended one egg per day for a healthy individual), thus creating a huge gap for the industry to expand (FAO, 2022). The country produced about 650 metric tons of egg and 300 metric tons of poultry meat in 2019 (FAO, 2022). Available records revealed that the average egg consumption in Nigeria was approximated at 78.48 eggs per person/annum in 2020 compared to 285.50 eggs/person/annum in the United States of America and 128.2 eggs/person/annum in South Africa (FAO, 2022; USDA, 2022). The deficiency is also prominent in poultry meat uptake among Nigerians. For instance, Nigeria consumes, on average, about 1.9 kg per capita of poultry meat compared to 49.3 kg for the USA, 7.67 for Ghana, and 32.98 kg for South Africa (Ayojimi et al., 2020). Despite the low per capita egg consumption rate in Nigeria, the country is presently witnessing a supply deficit (FAO, 2022). With the anticipated increase in the economic capacities of the population in urban and rural areas, the demand for poultry products is expected to rise due to improved effective purchasing capacities and a high youth population (Adesehinwa et al., 2019; Netherlands Enterprise Agency, 2020). The supply deficit constitutes a serious source of economic loss to the government of Nigeria. For instance, assuming full capacity was achieved in egg production, the sub-unit will generate about ₦800 billion or \$1.88 billion US dollars per annum (FAO, 2022).

Given the market potential available in the egg industry, the sub-unit has continued to attract sustainable investments (both local and international investments) following its increasing importance in diverse economic fields. Nutritionally eggs are

rich in high-quality proteins, easily digestible fats, carbohydrates, and minerals, including essential vitamins (Huopalahti et al., 2007; Madubuike, 2012; Ogunwole et al., 2015). Besides, poultry egg contains a trace of carbohydrates and all essential amino acids in a satisfactory proportion as required by the body for growth and body repair (Dolberg, 2003; Matt et al., 2009). Furthermore, eggs are raw materials for the pharmaceutical and cosmetic industries (Matt et al., 2009) and are one of the major additives in some food industries, among others.

However, the Nigerian poultry industry has myriad opportunities to explore the unutilized capacity and expand the frontier of value chains in the sub-sector. Currently, the poultry sub-sector contributes about 30% to the agricultural GDP and supports more than 10 million households' income and is a major player in Africa's poultry market. With an estimated 180 million birds (30% layers and 70% broiler), the country's poultry industry is ranked the second largest in Africa. It is worth more than 4.0 billion US dollars, out of which egg production contributes about 1.88 billion dollars (FAO, 2019). With the enormous investment prospects in the country's poultry sub-sector, the country's economy must be positioned adequately to nurture and sustain the thriving of the industry now and in the future. Often, several factors are reported to cause the depressed growth of the country's agricultural sector. The principal factor is the high volatility in the macroeconomic environment (Akpan & Umoren, 2021). The macroeconomic environment comprises monetary, fiscal, exchange rate regimes, and trade policies, including other complementary policies, developed to control production performances in the real and service sectors, among other sectors. The uncertainty

of the macroeconomic environment is known to impair growth in agricultural production and have a deteriorating effect on export promotion (Udah et al., 2015; Akpan, 2019; Udoh & Akpan, 2019; Akpan & Udo, 2021; Akpan & Umoren, 2021). Sound macroeconomic policies would birth sustainable and stable macroeconomic fundamentals, which are essential elements needed to achieve the country's short and long terms economic and developmental goals through agricultural innovations and development (Fan et al., 2008). In this dimension, many agricultural economists have documented empirical studies relating agricultural production to some selected macroeconomic fundamentals in Nigeria.

For instance, a positive impact of per capita income and credit to the agricultural sector on agricultural production have been submitted by several authors (Akpan, 2019; Udoh & Akpan, 2019; Akpan et al., 2021). Also, few authors have established an indirect relationship between the annual inflation rate, nominal exchange rate and growth in agricultural production in Nigeria (Oyakhilomen & Grace, 2014; Wasiu & Ndukwe, 2018; Gatawa & Mahmud, 2019; Obiageli, 2020). However, none of these researches has specifically focused on egg production as an independent agricultural output. Based on the time-dependent nature of the economic system and the increasing importance of egg production, there is an overwhelming need to update these batches of information and extend this research dimension to egg production in Nigeria. Based on this assertion, the study was intentionally designed to address the following objectives:

- (i) to examine the trend in egg production and
- (ii) identify the macroeconomic determinants of egg production in Nigeria.

Materials and Methods

Brief Description of Nigeria

The country is situated in the Gulf of Guinea in sub-Saharan Africa. The country lies 4° and 14° north of the equator and between longitude 3° and 15° east of Greenwich. The country's land mass is about 923,769 km² (or about 98.3 million hectares), with 853 km of coastline stretching along the northern edge of the Gulf of Guinea. The population is over two hundred (200) million (National Population Commission, 2021), and the country is gifted with abundant agricultural, mineral, marine, and forest resources. Its several vegetation zones, plentiful rain, surface water, and underground water resources and moderate climatic extremes allow for the production of diverse food, tree, and cash crops all year round. More than sixty percent of the population is involved in agricultural enterprises such as cassava, groundnuts, oil palm, cotton, rubber, cocoa, rice, maize, aquaculture, yams, various beans and legumes, sorghum, carrots, ginger, fruits, onions, tomatoes, melons, and vegetables among others. In addition,

artisanal fishery and livestock production such as poultry, goat, sheep, pigs, and cattle thrived in all regions of the country (Federal Ministry of Environment, 2021).

Data Source

The study used secondary or time series data sourced from the World Bank and Food and Agricultural Organization (FAO) as well as the Central Bank of Nigeria. The time series used spanned from 1961 to the year 2020.

Theoretical Framework

The study adopted a simple framework based on the production theory but assumed that production is also affected by non-physical factors. Generally, the theory of production depicts the unilateral relationship between the physical outputs of firm and physical inputs or factors of production. Explicitly a two-input production function can be expressed thus:

$$Q = f(K, L) \quad (1)$$

Note that Q represents the output, and K and L represent capital and labour inputs, respectively. The volume of Q of a firm at any time depends on the quantities of K and L utilized by that firm. Also, the availability of K and L inputs is determined by several factors, including macroeconomic factors and climatic as well as economy's stability, among others. The relationship implies that firm output depends on the physical inputs, while the physical inputs are determined by several non-physical factors within the economy. Explicitly the assumed relationship can be simplified as thus:

$$K, L = f(\text{Economic factors, climatic factors etc.}) \quad (2)$$

$$Q = f(K, L, \text{Economic factors, climatic factors etc.}) \quad (3)$$

By implication, the Q of a firm is also determined by non-physical factors, among others. Therefore, Eq. (3) was expanded to form the structural model used in this study.

Model Specification

Trend analysis of egg production in Nigeria

The exponential trend equation was specified and used to analyse the trend in annual egg production in Nigeria. The specified exponential trend equation is presented in Eq. (4).

$$\log_e EGG_t = b_0 + b_1 T + U_t \quad (4)$$

where, T is the time variable expressed in years. To estimate the exponential growth rate in egg production, Eq. (5) was specified according to Akpan et al. (2022) as thus:

$$(r) = (e^{b_1} - 1) \times 100 \quad (5)$$

To further extend the trend analysis of egg production in Nigeria, a quadratic trend equation was specified and estimated for egg production. The quadratic trend analysis allows for the determination of the coefficient of acceleration, deceleration and stagnation of egg production in the long run or increase

period. Hence, the quadratic trend equation (Akpan et al., 2022) is shown in Eq. (6).

$$\log_e EGG_t = b_0 + b_1 T_1 + b_2 T_2^2 + u_t \quad (6)$$

If $b_2 > 0$; the egg production is increasing at decreasing or increasing rate over a double increase of time: when $b_2 < 0$; the growth rate over double time is not significant.

Macroeconomics factors influencing egg production in Nigeria

A time-dependent multiple regression model was specified at the level of variables to determine the long and short-run determinants of egg production. The egg production equation adopted in the study assumed the following implicit Cobb-Douglas form, as shown in Eq. (7).

$$EGG_t = \beta_0 + \beta_1 CRE_t + \beta_2 EXC_t + \beta_3 PCI_t + \beta_4 CPI_t + \beta_5 MEC_t + \beta_6 MAI_t + \mu_t \quad (7)$$

where, EGG_t = Annual aggregate egg (hens) production measured in metric tons; CRE_t = annual credit injected in the agricultural sector (% of GDP); EXC_t = annual exchange rate of naira/dollar (proxy effect of external World influence); PCI_t = GDP per capita (naira/person) (proxy of demand capacity); CPI_t = Consumer price index (proxy of input prices); MEC_t = Meat (chicken) in tons (proxy of egg substitute); MAI_t = Quantity of maize produced in tons (proxy of poultry feed); U_t = the random error term and $U_t \sim \text{IID}(0, \delta^2_U)$.

To validate the stability in the long-run function of egg production in Nigeria, the study used the Engle and Granger (1987) two-step technique test. The pre-condition for applying the Engle-Granger two-step standard procedures of the cointegration tests is that the variables specified must be integrated in the same order. The additional condition is that the unit root of the error term from the long-run model should be

stationary at its level. If these conditions are fulfilled, then the error correction model (ECM) for the series can be estimated. The ECM represents the short-run production function for eggs in Nigeria. For the short-run production function of egg to hold, it is assumed that all other determinants of egg production are held constant or fixed. The specification of the ECM of egg production is implicitly expressed as in Eq. (8).

$$\Delta \ln EGG_t = \varphi_0 + \varphi_1 \sum_{i=1}^n \Delta \ln EGG_{t-i} + \varphi_2 \sum_{i=1}^n \Delta \ln X_{t-i} + \varphi_3 ECM_{t-1} + U_t \quad (8)$$

Note that specified variables are presented in Eq. (7) and the coefficient (φ_3) of the ECM_{t-1} ($-1 < \varphi_3 < 0$) measures the magnitude of deviation from the long-run equilibrium in period $(t-1)$.

Results and Discussion

Descriptive Statistics

The descriptive statistics of the specified variables are presented in Table 2. The findings revealed that the coefficient of variability and index of skewness in the annual per capita income and nominal exchange rate is greater than unity. This implies that the specified variables experienced high annual volatility and persistent increment across the specified period. The coefficient of variability was lowest in the amount of credit disbursed to the agricultural sector. This means that the amount of credit allotted to the agricultural sector over the years skewed positively but did not change significantly. The volatility indices in the quantity of egg, chicken meat and maize produced were less than unity and portrayed minimal variations in annual outputs across the study period. The skewness index for the chicken meat showed a negative sign, meaning that annual production increased at a decreasing rate.

Table 2. The descriptive statistics of variables.

Variable	Min.	Max.	Average	Std. deviation	CV	Skewness
EGG	75000	6.6000e+005	3.4076e+005	2.0149e+005	0.59129	0.27559
PCI	69.272	7.2470e+005	1.2975e+005	2.1162e+005	1.6310	1.5542
EXC	0.54678	306.90	66.541	92.206	1.3857	1.3159
MEC	30000	2.7300e+005	1.4863e+005	71441	0.48067	-0.13854
MAI	4.8800e+005	1.1548e+007	4.5113e+006	3.4666e+006	0.76842	0.42199
CRE	3.7043	19.626	8.5270	3.2587	0.38216	1.3525

Data are derived from FAO and World Bank, 2022.

Trend in Egg Production in Nigeria

The estimated exponential trend equation of egg production is shown in Table 3. The findings showed that egg production in Nigeria relates positively to time. This means that egg production increases with an increase in the time factor. The result revealed an average positive exponential growth rate of

4.02% per year in Nigeria. This growth rate in egg production showed remarkable improvement compared to the 3.90% growth rate per year obtained for Africa in 2017. This implies that several policies and programmes implemented by the government to boost poultry production yielded significant and positive impacts. In addition, the quadratic trend equation

reveals that egg production over time increases at a decreasing rate. The pictorial representation of the estimated trend line is fitted to the linear graph of egg production and is shown in Figure 1. The trend in egg production assumed an upward progressive growth from 1961 to 1987. This period corresponds

to the pre-structural adjustment programme (SAP). The agricultural policies and programmes then were majorly targeted at developing the agricultural sector at the regional levels.

Table 3. The trend analyses of egg production in Nigeria.

Variable	Coefficient	Standard Error	t-value
Exponential trend equation			
Constant	11.3229	0.0354	319.7***
Time factor	0.0394	0.0010	39.05***
Focal. (1, 58)	1524.664***		
R-squared	0.9634		
Exponential growth rate (%)	4.0186		
Quadratic trend equation			
Constant	11.0736	0.0331	334.3***
Time factor	0.0636	0.0025	25.37***
Time factor squared	-0.0004	3.98e-05	-9.934***
Focal. (2, 57)	2095.67***		
R-squared	0.9866		

***Represent a 1% significance level.

Following the influx of foreign exchange resulting from the crude oil export in the 1970s, import substitution was introduced to establish heavy-duty agro-industries such as flour mills. The period marks the birthing of pronouncing private investment in the poultry industry. The trend in egg production witnessed a sharp depression in 1988 and 1989 and later an upsurge from 1990 to 1995. The trend in egg production in this period was mainly modelled by the policies and programmes of the structural adjustment programme. The remarkable characteristic of this era was the privatisation and commercialization of government-owned agro-enterprises. During this time, private investment in poultry production witnessed a remarkable increase, but improvement in the sub-sector was hampered by increasing volatility in the macroeconomic fundamentals. Also, the industry depended so much on imported inputs, and this caused a sharp decline in egg production in 1997. The post-SAP era, which spanned from 1993, saw the introduction of new agricultural policies, including a ban on importing many poultry essential inputs, the devaluation of the national currency and independence of the poultry sub-sector. Egg production struggles to thrive in the harsh economic weather prevalent in the country. However, from 2010 to 2020, the agricultural transformation agenda was introduced to strengthen private investment in the poultry sub-sector. Enhanced finances, research and several collaborative initiatives were established to boost poultry outputs, including egg production.

This period corresponds to or is noted for a conspicuous increase in egg production until early 2020. The COVID-19 pandemic and persistent increase in feed prices stalled the production capacity of eggs and resulted in a reduction in annual output. In summary, the trend in egg production has shown undulating behaviours from 1961 to 2020, which corresponded to the various impacts of policies and programmes enunciated to improve capacity utilization in the sub-sector. However, the overall growth has been impressive considering the uncertainty that wraps up the entire economic system in the country.

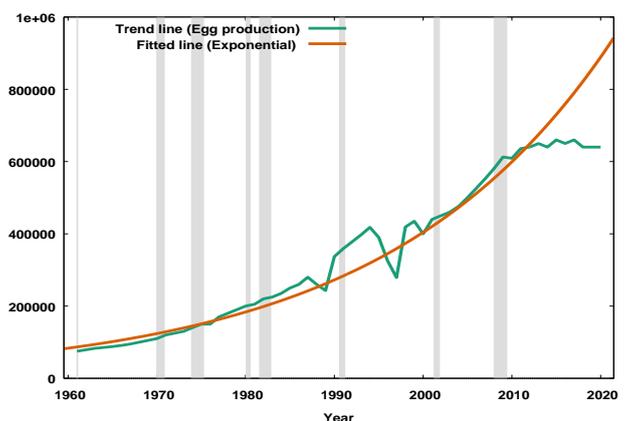


Figure 1. Trend in egg production in Nigeria.

Determinants of Egg Production in Nigeria

Unit root test

The study employed the Augmented Dickey-Fuller (Dickey & Fuller, 1979) test and the ADF-GLS unit root test developed

by Elliott et al. (1996) to confirm the unit root of the variables. The results of the unit root test of variables are presented in Table 4. The results revealed that all variables were not stationary at their levels but were stationary at the first difference.

Table 4. Unit root test using ADF and ADF-GLS methods.

	ADF (with constant)				ADF-GLS (with constant and trend)			
	Lag	Level	1 st Diff.	Decision	Lag	Level	1 st Diff.	Decision
EGG	0	-1.6036	-7.8774***	1(1)	0	-1.9968	-7.8774***	1(1)
PCI	0	-0.3684	-6.2718***	1(1)	0	-1.6976	-6.3379***	1(1)
EXC	0	0.2398	-5.9813***	1(1)	0	-1.8439	-6.0820***	1(1)
MEC	0	-3.0267	-7.6005***	1(1)	0	-1.6417	-8.5692***	1(1)
MAI	0	-0.6701	-8.0437***	1(1)	0	-2.1053	-8.1172***	1(1)
CRE	0	-2.8873	-7.8814***	1(1)	0	-0.3302	-7.9262***	1(1)
CPI	0	0.3315	-3.5437***	1(1)	0	-1.6621	-3.6447***	1(1)
Residual	0	-4.8357***				-4.8788***		

***Indicate 1% significance level. Variables are expressed in a natural logarithm.

The result for ADF is similar to ADF-GLS unit root tests. The result implies that if variables are used at their levels, the possibility of producing spurious regression estimates is high if variables are used at their levels. Hence, following the recommendations given by Johansen and Juselius (1990) such specifications should be tested for the existence of cointegration. Therefore, the cointegration test was conducted for specified variables in Eq. (7).

The Engle-Granger two-step cointegration test

The unit root test results presented in Table 4 for the error term showed that the null hypothesis for no cointegration is rejected at a 1% probability level of significance, the null hypothesis of no cointegration is rejected. The inference is that there is a long-run equilibrium relationship between egg production and the specified macroeconomic fundamentals as well as other relevant variables in Nigeria.

The long-run determinants of egg in Nigeria

The long-run determinants of egg production function in Nigeria are presented in Table 5. The result revealed that; the per capita income of Nigerians (which proxies demand capacity) has a significant positive influence on egg production. It implies that egg production increases as the demand capacity increases. The probable reason for this finding is traceable to the fact that eggs are affordable and are easily found as well as being preferred by all classes of people in society when their incomes increase, hence one of the normal goods. The result is confirmed by Akpan (2019); Udoh and Akpan (2019), Akpan et al. (2021).

The slope coefficient of chicken meat has a positive significant relationship with egg production in Nigeria. The relationship connotes that as broiler production increase, egg production also increases. This could be related to the fact that the two poultry products often are jointly produced by farmers as a way to ensure all round farm income and avert risks and uncertainties associated with agricultural production. This means that an increase in the production of one enterprise would increase the production of the other enterprise. The result also revealed that the quantity of maize produced and the amount of credit disbursed to the agricultural sector are significant positive determinants of egg production in Nigeria. Maize is one of the major constituents of poultry feed, and its production is critical to the volume of poultry feed. Hence, an increase in the production of maize will increase the possibility of producing more poultry feeds at affordable prices. Affordable poultry feed would enhance egg production by lowering the cost of production. Credit disbursed to the agricultural sector has been established as one of the major stimulants of agricultural growth. It enhances the acquisition of farm inputs and encourages economies of scale in agro-production.

The result corroborates Oyakhilomen and Grace (2014), Wasiu and Ndukwe (2018), Gatawa and Mahmud (2019), Obiageli (2020). On the other hand, the consumer price index, which proxies input prices, relates negatively to egg production in the country. This means that as the consumer price indices increase, the possibility of increasing egg production declines, probably due to the high prices of inputs. The finding agrees with Akpan and Umoren (2021).

Table 5. The long-run estimates of egg production equation.

Variable	Coefficient	Standard Error	t-value	Probability
Constant	4.3856	0.7152	6.132	<0.0001
PCI _t	0.1703	0.0516	3.300***	0.0017
EXC _t	0.0299	0.0304	0.9832	0.3300
MEC _t	0.4813	0.0608	7.920***	<0.0001
MAI _t	0.0564	0.0328	1.718*	0.0917
CRE _t	0.0888	0.0469	1.890*	0.0642
CPI _t	-0.0976	0.0329	-2.967***	0.0061
R-squared	0.986378	Adjusted R-squared		0.984836
Focal. (4, 55)	639.6311***			

Variables are expressed in the natural logarithm. * and *** represent 10% and 1% significance levels, respectively.

The short-run egg production in Nigeria

The error correction model was estimated to capture the dynamics in the egg production equation and identify the speed of adjustment as a response to departure from the stable long-run equilibrium. The study used Hendry (1995)'s technique to obtain an acceptable ECM model for egg production in Nigeria. The ECM estimates are presented in Table 6. The result

revealed that the slope coefficient of the error term is negative and statistically significant, thus validating the existence of stable long-run equilibrium for the estimated egg equation. The result also implies that egg production is sensitive to the departure from its equilibrium value in the previous periods. This connotes that the adjustment speed in the egg production equation is the same no matter the shock in the specified explanatory variables.

Table 6. The estimated short-run egg equation in Nigeria.

Variable	Coefficient	Standard Error	t-value	Probability
Constant	0.0165	0.0185	0.8891	0.3783
Δ EGG _{t-1}	0.1776	0.1783	0.9960	0.3241
Δ LnPCI _t	0.1144	0.0637	1.797*	0.0785
Δ LnEXC _t	0.0063	0.0251	0.2493	0.8041
Δ MEC _t	0.1025	0.0744	1.377	0.1748
Δ LnMAI _t	0.0529	0.0314	1.686*	0.0982
Δ LnCRE _t	0.1043	0.0539	1.936*	0.0586
Δ LnCPI _t	-0.0869	0.0346	-2.512**	0.0117
ECM _{t-1}	-0.5946	0.2446	-2.431**	0.0188
Diagnostic tests				
R-squared	0.7320032	Adjusted R-squared		0.60902
F (6, 52)	16.6891***			

* and ** represent 10% and 1% significance level, respectively.

However, the slope coefficient of the ECM (-0.5946) representing the speed of adjustment is consistent with the hypothesis of convergence towards the long-run equilibrium. The diagnostic test for the ECM model revealed an R² value of 0.732 and a significant F-calculated, hence assuring the fitness of the estimated equation.

The empirical result shows that the per capita income, the quantity of maize and credit disbursed to the agricultural sector are positive significant short-run determinants of egg production in Nigeria. Alternatively, the consumer price index exerted an adverse influence on egg production in the short-run period.

Stability test

Figure 2 represents the CUSUM with a 95% confidence band generated from the ECM. Note that all residuals are located between the two standard deviation limits at a 5% confidence interval. The result indicates that the short-run model (ECM) is stable, as it is maintained within the 5 per cent significance level within the observation period. Further stability tests are presented in Table 7. The result showed that the estimated short-run model is adequately specified, and the error terms are normally distributed.

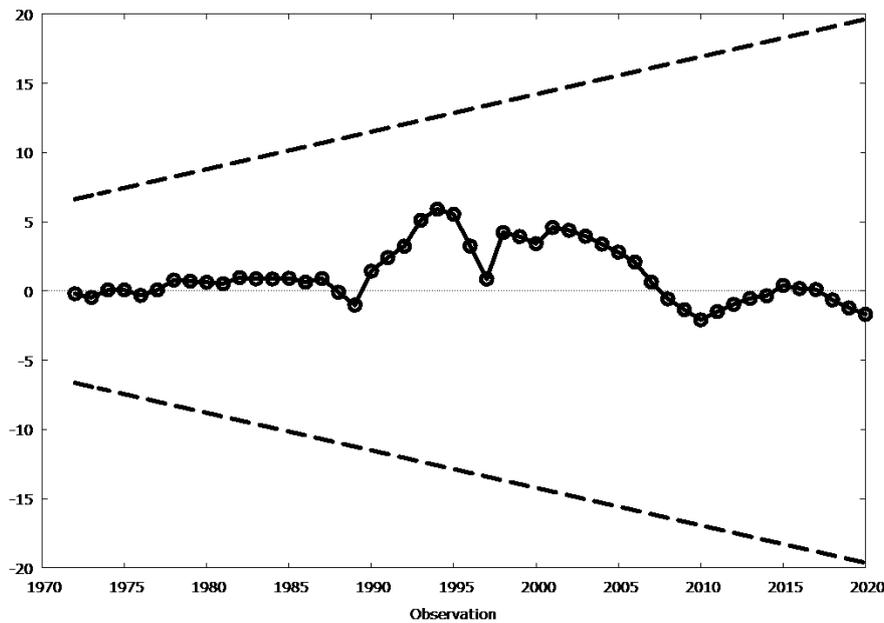


Figure 2. CUSUM plot with 95% confidence band.

Table 7. Test of validity of parameters in ECM.

Test	Value	Inference
RESET test	1.1207	Specification is adequate
Normality test	1.6703	Error normally distributed
White test	17.2485	Heteroscedasticity not significant
CUSUM test	-0.2404	No change in parameters

The result of the Reset test revealed that the estimated equation is adequate with efficient structural rigidity, while heteroskedasticity did not pose a serious problem.

Conclusion

The study has established that egg production has a significant relationship with some key macroeconomic fundamentals, egg substitute (chicken meat) and maize production (a major constituent of animal feeds) in both short and long-run periods in the country. The study also confirmed that the inflation rate (proxy by the consumer price index) relates adversely to egg production in the immediate and long-run periods. The need to increase egg production from the present growth rate of 4.02% is obvious given the devastating levels of the per capita consumption of eggs and the corresponding economic loss due to deficit supply as well as the deficiency in protein consumption across categories of Nigerians. The alarming level of malnutrition and high level of unemployment, as well as poverty, can be curtailed drastically using the weapon of egg production enterprises which many experts attest to as being profitable and sustainable. Within the ambit of this study, an upsurge in egg production can be achieved by improving the per capita income of Nigerians. Providing adequate credit facilities is proven effective in surging egg production. Adopting necessary agronomical

techniques to increase maize production is recommended as a pathway to increase egg production in Nigeria. Enhancing value addition in the poultry sub-sector through an increase in chicken meat production would additionally increase egg production. Besides, a reduced and stable inflation rate in the country is necessary and strongly recommended for the survival of egg enterprises in the country.

Conflict of Interest

The authors declare that they have no conflict of interest.

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