



**EFFECTS OF GROSS FIXED CAPITAL FORMATION AND SELECTED
INTERNATIONAL TRADE POLICY INSTRUMENTS ON
AGRICULTURAL PRODUCTIVITY IN NIGERIA:
AN AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) MODEL APPROACH**

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ABSTRACT

The study assessed the agricultural productivity effects of gross fixed capital formation, exchange rate and agricultural tariff. The study utilized secondary data spanning from 1980 to 2022. Augmented Dickey Fuller Test was used to test for stationarity among variables, Johansen Cointegration test was used to test for long run relationship between variables. Vector Error Correction Model was used to analyze the effect of gross fixed capital formation, agricultural tariff and exchange rate on agricultural productivity. The result of the Augmented Dickey Fuller (ADF) test for unit root indicated that the variables agricultural output and gross fixed capital formation were stationary at level while, agricultural tariff and exchange rate became stationary on first differencing. Further investigation into the series properties of the variables through the use of Johansen co-integration mechanism indicates that there was one co-integrating equation among the variables. The results of the ARDL for long-run indicated that Cointegrating equation [CointEq(-1)] was statistically significant and negative (-0.171646) at 1% probability level ($p < 0.01$) indicating a moderate speed of adjustment (that is, the speed at which the deviation from long run equilibrium is adjusted quickly where 0.171 of the disequilibrium is removed immediately in each period). Specifically, the coefficients of inflation rate (-0.103255) and agricultural tariff (-1.110961) were negative and statistically significant at 1% probability level ($p < 0.01$). The study concluded that raising trade policy instruments such as inflation rate and agricultural tariff will negatively affect agricultural productivity. The study therefore recommended that Government should lower tariffs on agricultural goods so as to encourage import and exports within the agricultural sector. This will promote local production and boost productivity.

Key words: Agricultural Productivity, Gross Fixed Capital Formation, International Trade, Policy, ARDL.

INTRODUCTION

Agricultural productivity refers to the rise in per capita output of agricultural produce within an economy during a given period of time. The period of time can be monthly, quarterly or annually. However, the annual period of time is usually adopted by most researchers in the field of economists and statistics due to the accurate and coherent information it tends to offer. Agricultural productivity refers to the output produced by a given level of inputs in the agricultural sector of a given economy (Amire, 2016). More formally, it can be defined as the ratio of the value of total farms outputs to the value of total inputs used in farm production (Iwala, 2013). Agricultural productivity is measured as the ratio of final output, in appropriate units to some measure of inputs. Singh and Dhillon (2000) suggested that yield per unit should be considered to indicate agricultural productivity. Many scholars criticized this suggestion while pointing out that the approach only considered land as the factor of production.



Several researchers were of the opinion that agricultural productivity should contain all the factor of production such as: labor, farming experiences, fertilizers, availability and management of water and other biological factors. Also, agricultural productivity can be measured by total factor productivity (TFP). This method of calculating agricultural productivity compares an index of agricultural inputs to an index of outputs. Increase in TFP is usually attributed to technological progress. Agricultural productivity is very significant, because it increases food production and farmer's prospects for growth and competitiveness in the agricultural market. As farmers adopt new techniques and differences, the most productive farmers benefit from an increase in their welfare while farmers who are not productive enough will exit the market to seek success elsewhere (Yair, 2007). Agricultural productivity is becoming increasingly important as the world population continues to grow. It is not only the people employed in agriculture who benefit from increases in agricultural productivity, generally increase in agricultural productivity is beneficial to all citizens in a country as it improves food security, promotes international trade, improves gross domestic product, among others.

Gross fixed capital formation (GFCF) consists of resident producers' investments, deducting disposals, in fixed assets during a given period. The GFCF time series data is often used to analyse the trends in investment activity over time, deflating or redeflating the series using a price index. But it is also used to obtain alternative measures of the fixed capital stock Both the Keynes and neo-classical economists recognize that investment is a derivative of savings. As noted by Ciftcioglu and Begovic (2010), neo-classical model and most of the different versions of new generation growth models predict a positive effect of higher saving rate on economic growth, at least, in the short to medium term. In addition, Solow's neoclassical growth model has shown how the saving rate could affect the growth rate of output. In Solow's model, even though an increase in saving rate has no effect on the steady state (long-run) growth rate of output per worker, it still positively affects the living standards permanently by increasing the steady state amount of stock of capital per worker which, in turn, allows an increase in output per worker in the long run (Ciftcioglu and Begovic, 2010).

One of the basic problems confronting the development of agricultural sector in Nigeria could be attributed to inadequate savings and investment by households, government and other relevant agencies. Agriculture in Nigeria like in most developing countries is predominated by small-holder farmers, and several constraints and barriers which appears insurmountable, limit the overall farming activities. Low saving capacity of farm families is one of the predominant factors responsible for stagnation of agricultural sector in Nigeria. However, adequate and comprehensive rural savings scheme that will motivate the farmers to use their capital productively is lacking (Odoemenem *et al*, 2013).

Agricultural productivity is said to be declining, however, there appears to be some rise and fall between the early 2000s till date. To understand the reason for this fluctuation, this paper attempt to answer this pertinent question; what is the impact of gross fixed capital formation, exchange rate and agricultural tariff on agricultural productivity. A number of research work has been carried out on the effect of trade policies on economic growth in Nigeria. For example; (Guzman, *et al.*, 2018) examined the impact of exchange rate policies on economic development and observed that a stable and competitive exchange rate policy can positively impact on any observed externality and any market distortions, which will in turn induce positive economic growth. Adekunle and Aderemi (2012) examined the relationship between Domestic Investment, Capital Formation and Growth in Nigeria. The result showed that the rate of investment does not assist the rate of growth of per capita GDP in Nigeria.



Mustafa *et al.* (2001), carried out a research in which they had discussed the role of World Trade Organization in policy making related to agricultural trade. In this research, they had examined that WTO had made certain rules in which they had put tariffs on the export of developed countries which had help developing countries like Pakistan. This tariff which is imposed on developed countries helped in this sense that when there was less tariff on exporting agriculture commodities so this may ultimately effects the prices of good or commodities of the developing countries because due to the technological advancement developed countries can produce that same commodities cheaply or sometime these countries do dumping to attain the market in developing countries which had an direct effect on the domestic demand of that countries and then there imports start increases and exports may leads to decline so then this may lead to declines in agricultural commodities.

Krueger, (1997), Bleaney, (1999) and Ahmed, (2002), had mentioned in their paper on effects of economic reform policies on agricultural exports that the results were inconclusive. While there are many studies done on this, some suggest that there is positive relationship among economic reform policies on agricultural exports. Another study was done which investigates the relationship among the agriculture trade policy and how it influence the trade liberalization on agriculture exports performance specifically openness, competitiveness and diversification, in their study, they analyzed that competitiveness and diversification has a positive relationship with exports policy and openness has negative relationship with exports policy and suggests that supply-side factors influence the exports policy, while imports has a negative impact on agricultural productivity as mentioned above. The impact is negative because imports of agriculture products means that either it has shortage in the country or the prices of that commodity or good is higher than of international product so this may ultimately effect the agriculture productivity besides this there are also some other factor which may lead to increase in imports of the agricultural products which are quality, per capita income. Per capita income increase means that when the average person income increases so this may ultimately increase the demand for import product and then as an effect the agriculture productivity decrease because then it will be less incentive or profit for making that product.

Hassine, *et al.*, (2010), explored the agricultural trade liberalization, productivity gain, and poverty mitigation in Tunisia. The model which were used in this research is Assessable General Equilibrium models to investigate the impact of trade liberalization situations on poverty and equity in Tunisia. Findings of this study showed that initial up of foreign trade increases productivity growth and poverty also drop by 11 percent under the agricultural trade liberalization policy. Mustafa *et al.* (2001), carried out a research in which they are had discuss that WTO role in policy making related to agriculture trade in this research they had examine that WTO have make certain rules in which they had put tariffs on the export of developed countries which had help developing countries like Pakistan. This tariff which is imposed on developed countries helped in this sense that when there was less tariff on exporting agriculture commodities so this may ultimately affect the prices of good or commodities of the developing countries because due to the technological advancement developed countries can produce that same commodities cheaply or sometime the these countries do dumping to attain the market in developing countries which had an direct effect on the domestic demand of that countries and then there imports start increases and exports may leads to decline so then this may lead to declines in agricultural commodities.

Despite the above-mentioned studies, little or no study has been carried out on the agricultural productivity effects of gross fixed capital formation and selected international trade policy instruments, especially in Nigeria. Thus, necessitating this paper in an attempt to bridge



the research gap, through the utilization of the Autoregressive Distributed Lag (ARDL) Model and contribute to existing knowledge.

METHODOLOGY

The Study Area

The study area is Nigeria. Nigeria is located on the Gulf of the Guinea in West Africa with a geographical area of 923, 768 square kilometers. It is one of the eight most populous countries in the world with a population of about 140 million (NPC, 2006). With a population growth rate of 2.6%, Nigeria has an estimated population of about 223.8 million in 2023 (www.statista.com). Nigeria lies wholly within the tropics along the Gulf of Guinea on the western coast of Africa. The vegetation ranges from mangrove swampland along the coast to tropical rain forest and savannah to the north. Nigeria is located between latitude $4^{\circ} 16'$ and $13^{\circ} 53'$ north and longitude $2^{\circ} 40'$ and $14^{\circ} 41'$ east (CIA Fact Book, 2009). Because Nigeria has a highly diversified agro-ecological climate, agriculture is one of the most important sectors of the Nigeria economy. The climate varies with Equatorial in South, Tropical in Centre and in the North. In the North, the vegetation is grassland savannah and, in the south, forest. Because of this vegetation, agriculture is the major employer of labour in the country. In terms of employment, at least 60% of Nigeria's projected population of 210.87 million, is estimated to be engaged or employed in agriculture (mainly small holders). Women make up to 60-80 percent of work or labour and produce two thirds of food crops.

Data Collection and Data Analysis Technique

The study made use of secondary data spanning from 1980 to 2022. The data were sourced from National Bureau of Statistics (NBS) database. Agricultural productivity was proxied by aggregate of agricultural output index, exchange rate was measured as annual average exchange rate of Nigeria Naira to one US Dollar. Agricultural tariff was measured as Free On Board on import and export goods/revenue from agricultural imports and exports, gross fixed capital formation was measured in millions of US Dollars and inflation rate which was used as dummy variable was measured as percentage change in the general price of all goods and services (%)

The major method of analysis employed in this study was the Autoregressive Distributed Lag (ARDL) model. However, since time series variables are used, it is essential to examine their properties so as not to end up with a spurious regression. Therefore, all variables were examined through unit root tests. To examine the long run relationship among the variables, Johansen cointegration test was conducted while the short-run and long-run analysis was done via the Autoregressive Distributed Lag (ARDL) model.

Model Specification

The model was specified as follows;

$$\Delta \ln Apr_t = a_{0i} + \beta_{1i} \ln Apr_{t-1} + \beta_{2i} \ln EXGR_{t-1} + \beta_{3i} \ln INFR_{t-1} + \beta_{4i} \ln INTR_{t-1} + \beta_{4i} \ln GFCF_{t-1} + \sum_{i=1}^p a_{1i} \Delta \ln Apr_{t-i} + \sum_{i=1}^q a_{2i} \Delta \ln EXGR_{t-i} + \sum_{i=1}^q a_{3i} \Delta \ln INFR_{t-i} + \sum_{i=1}^q a_{4i} \Delta \ln INTR_{t-i} + \sum_{i=1}^q a_{5i} \Delta \ln GFCF_{t-i} + \varepsilon_{1t} \text{-----} (1)$$

Where,

Apr = Agricultural Productivity

EXGR_t = Exchange Rate (Dollar/Naira)

INFR_t = Inflation Rate

INTR_t = Interest Rate

ECM = error correction term

ut = error term



RESULTS AND DISCUSSION

Unit Root Test

The result indicated that all the variables (exchange rate, gross fixed capital formation, agricultural tariff and agricultural output) were found to be statistically significant and 1%. The variables agricultural output and gross fixed capital formation were stationary at level while, agricultural tariff and exchange rate became stationary on first differencing. This indicates that the variables exhibit random walk (unit roots) or the future values of these variables do not converge from their past values. Thus, the null hypothesis of non-stationary of the data was rejected.

Table 1: Unit Root Test

Variable	Level				First Difference				
	ADF	1%	5%	10%	ADF	1%	5%	10%	Inference
Agric Output	-4.00***	-3.639	-2.951	-2.614					I (0)
Agric Tariff	-1.517	-3.605	-2.936	-2.606	-9.358***	-3.605	-2.936	-2.606	I (1)
Exchange Rate	-2.857	-3.605	-2.936	-2.606	-4.855***	-3.605	-2.936	-2.606	I (1)
GFCF	-4.70***	-3.646	-2.954	-2.615					I (0)

*** Significant at 1%

Source: Data analysis, 2023.

Johansen Co-integration Test

Using maximum Eigen statistics (41.63306), the result revealed that combination of these variables has one co-integrating equation and this means that linear combination of these variables has a single long run linear combination of relationship or one co-integrating equation. This implies that a long run relationship exists among agricultural output, exchange rate, agricultural tariff and gross fixed capital formation.

Table 2: Johansen Co-integration Test

Trace				
Hypothesized No. Of Cointegrating Equation(s)	Eigenvalue	Trace Statistics	0.05 Critical value	Prob**
None *	0.750368	111.5074	95.75366	0.0004
At most 1*	0.672835	69.87439	69.81889	0.0003
At most 2	0.493990	36.35564	47.85613	0.6321
At most 3	0.325691	15.91966	29.79707	0.5758
At most 4	0.126386	4.097663	15.49471	0.1043
At most 5	0.001471	0.044172	3.841466	0.5674

Maximum Eigenvalue				
Hypothesized No. of Cointegrating Equations(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical value	Prob**
None *	0.750368	41.63306	40.07757	0.0007
At most 1	0.672835	33.51875	33.87687	0.0581
At most 2	0.493990	20.43598	27.58434	0.7360
At most 3	0.325691	11.82199	21.13162	0.8176
At most 4	0.126386	4.053491	14.26460	0.1043
At most 5	0.001471	0.044172	3.841466	0.3243

Lag Length Selection Criteria

The result of the lag length selection criteria is presented in Table 3. VAR model was fitted to the time series data in order to find an appropriate lag structure for the analysis. This was necessitated by the sensitivity of time series analysis to lag length structure (Foresti, 2006; Afzal, 2012; Oyinbo and Emmanuel, 2012). Based on the result in Table 3, the lag length which minimizes SC, AIC and HQ is lag one and thus our optimal lag length.

Table 3: Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-77.19821	NA	4.73e-05	9.905672	10.24876	9.939775
1	97.27262	184.7338*	3.23e-11*	-4.855603*	-2.110900*	-4.582774*
2	-53.35303	115.6852	2.28e-05	8.797391	13.41599	10.40940

Source: Data Analysis, 2023.

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion



Augmented Autoregressive Distributed Lag Bounds Test for Cointegration

The result showed that the F-statistic (4.320708) was greater than the $I(0)$ and $I(1)$ bound values of 3.12 and 4.25 respectively at 5% level of significance, thus indicating the presence of a long run relationship among the variables. Therefore, the null hypothesis which stated that there is no long-run relationship between the variables was rejected. Hence prompting the conduct of ARDL test for long run relationship.

Table 4: Augmented Autoregressive Distributed Lag Bounds Test for Cointegration

Test Statistic	Value	k
F-statistic	4.320708	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.75	3.79
5%	3.12	4.25
2.5%	3.49	4.67
1%	3.93	5.23

Source: Data Analysis, 2023

Diagnostic Tests

Different diagnostic test values demonstrated at Table 5 and it shows that ARDL model is a fully fitted model for long run as well short-run result for testing the variables. Serial correlation under correlogram with insignificant value squared correlogram negligible value, and Breusch Godfrey LM test illustrates F-statistics (3.150962) at probability values (0.702) which denoted that residuals serially uncorrelated and normally distributed. Likewise, findings of heteroscedasticity test declared that data series are homoscedastic, because the Breusch-Pagan-Godfrey F-statistics (3.329534) and probability value (0.346), cannot discard null hypothesis of homoscedasticity of variables.

Table 5. Diagnostic Tests Results

Statistics	F-statistics	P-value
Serial Correlation	3.150962	0.702
Heteroskedasticity	3.329534	0.346

Source: Data Analysis, 2023.

CUSUM of Squares Test

Finally, the CUSUM square (CUSUMSQ) test, proposed by Brown, Durbin, and Evans (1975), is employed to investigate the stability of the model. As seen in Figure 1, the plot of the CUSUMSQ line does not break the limits which imply that the coefficients are stable.

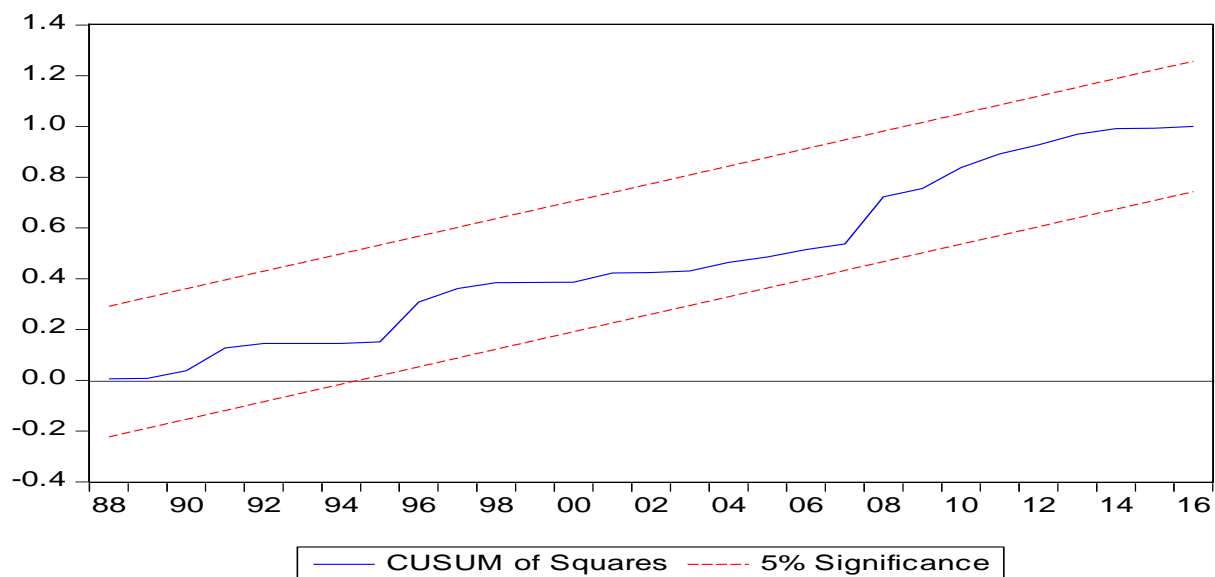


Figure 1: CUSUM of Squares Test

Effect of Gross Fixed Capital Formation, Exchange Rate and Agricultural Tariff on Agricultural Productivity

The result of ARDL as shown in Table 6 indicated that Error Correction Term [ECT (-1)] is statistically significant and negative (-0.171646) indicating a moderate speed of adjustment (that is, the speed at which the deviation from long run equilibrium is adjusted quickly where 0.171 of the disequilibrium is removed immediately in each period). The result implies that 17.1% deviation from equilibrium position is corrected within the year.

Specifically, the coefficients of inflation rate (-0.103255) and agricultural tariff (-1.110961) were negative and statistically significant at 1% probability level, implying that in the long run increase in inflation rate and agricultural tariff will lead to decrease in agricultural productivity. This result is consistent with the result of Orji and Mba (2012), who found that the long run impact of capital formation on economic growth is larger than their short-run impact. This implies that a unit increase in inflation rate and agricultural tariff will decrease agricultural productivity by 1.110961 units *ceteris paribus*.

Table 6: The Autoregressive Distributed Lag (ARDL) Model for Long-Run Effect of Gross Fixed Capital Formation, Exchange Rate and Agricultural Tariff on Agricultural Productivity.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.171646	0.02527	-6.790972	0.0000
GFCF LCU	0.296424	0.253616	1.168789	0.2556
INFLATION RATE	-0.103255	0.138377	0.746190	0.0038
AGRIC TARIFF	-1.110961	0.276433	-4.018915	0.0006
EXCHANGE RATE	-0.006680	0.202423	-0.033002	0.9740
C	-1.398944	6.509054	-0.214923	0.8319
@TREND	-0.090911	0.038744	-2.346445	0.0288

Source: Data Analysis, 2023.



CONCLUSION AND RECOMMENDATIONS

The study concluded that increasing Gross Fixed Capital Formation will increase agricultural productivity. The implication of this is that people will concentrate more on investment in produced fixed assets in the agricultural sector thereby increasing productivity. Hence government should set up policies that will encourage continued investment in agricultural sector other than sectors that will not promote agricultural productivity. Also, the study revealed that, exchange rate and agricultural tariff affect agricultural productivity. Raising any of these instruments will lead to adverse effects on agricultural productivity. The study therefore recommends that;

- i. Government should lower tariffs on agricultural goods so as to encourage import and exports within the agricultural sector. This will promote local production and boost productivity.
- ii. Also, Monetary policy that encourages lending to the agricultural sector would help to smooth the effects of various shocks in agriculture thereby keeping any interest rates and exchange rates in check.

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