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Macroeconomic and Climatic Determinants of Ginger Productivity in Nigeria (1961-2016)

Nijerya'da Zencefil Üreticiliğinin Makro Ekonomik ve İklimsel Belirleyicileri (1961-2016)

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ABSTRACT

The study analyzed the macroeconomic and climatic determinants of ginger productivity in Nigeria from 1961 – 2016. The Malmquist productivity index was used to estimate the productivity of ginger while Auto Regressive Distributed Lag Model was used to estimate the long-run and short-run determinants of ginger productivity. The results reveal that the productivity of ginger has been experiencing a marginal increase over the period studied. Temperature and rainfall had a long run negative and positive impact respectively on ginger production showing the strong influence of climate change. Capital had both positive and negative impacts on the productivity of ginger in the long run and short run. It is therefore recommended that the availability and accessibility of capital are very essential for the increased production of ginger in Nigeria and there should be efforts to manage the impact of climate change through the availability of irrigation facilities.

Anahtar kelimeler:

Zencefil
Verimlilik
Makroekonomik
İklim

ÖZET

Çalışma, 1961-2016 yılları arasında Nijerya'daki zencefil üretkenliğinin makroekonomik ve iklimsel belirleyicilerini analiz etmektedir. Zencefil verimliliğini tahmin etmek için Malmquist verimlilik endeksi kullanılmış iken, zencefil üretkenliğinin uzun dönem ve kısa vadeli belirleyicilerini hesaplamak için ise Otoregresif Dağıtık Gecikme Modeli kullanılmıştır. Sonuçlar zencefil üretkenliğinin incelenen sürede marjinal bir artış yaşadığını ortaya koymaktadır. Sıcaklık ve yağış, iklim değişikliğinin güçlü etkisini gösteren zencefil üretiminde uzun vadede sırasıyla olumsuz ve olumlu bir etki yaratmıştır. Bu nedenle, Nijerya'da zencefil üretiminin artması için sermaye sağlanması, sulama tesislerinin bulunması yoluyla iklim değişikliğinin etkisinin yönetilmesi için çaba gösterilmesi gerekmektedir.

1. INTRODUCTION

Ginger is an important tuber crop apart from its nutritional and medicinal benefits it is an economic crop that can contribute meaningfully to the economic growth and development of Nigeria. Ginger (Zingiber Officinale Roscoe) is a crop mostly grown in northern Nigeria with Kaduna State as the chief producer (Ayodele & Sambo, 2014). Other parts of Nigeria known for the production include Benue, Bauchi, Gombe, the Nassarawa States among other states. Ginger is readily available in the local markets as a fresh ginger rhizome, powder ginger and dry ginger rhizome (Omeni, 2014). Nigeria produces an average of 50000 metric tonnes of fresh weight ginger per anum (Ezeagu, 2006) and about 10% is consumed locally while remaining 90% are exported. There are two major species of ginger grown in Nigeria which is the reddish and yellowish varieties.

The ginger farmers in Nigeria are mainly smallholder farmers and are challenged by the unavailability of large hectares of land for mechanized farming. These farmers are widely regarded as poor due to their level of income, making it difficult for them to access enough credit facilities to finance their farming activities especially for the purchase of fertilizer and chemical required for farming. The challenge of the low price of the ginger products tends to repel most of the farmers from continuing the farming of ginger (NdaNmadu & Marcus, 2011). The price of ginger from Nigeria is unattractive and this has been attributed to the low quality of ginger from Nigeria which is not competitive in the international market. The production and yield of ginger in Nigeria have been low despite government efforts to increase the output and yield, this is attributed to poor policy implementation, poor farming practices, unimproved varieties, laborious and unskilled farming, poor capital access, climate change, low level of mechanization, inaccessibility of fertilizer and other chemicals, poor policy attention among others (Ayodele & Sambo, 2014; NdaNmadu & Marcus, 2011; Folorunsho & Adenuga, 2013). Nigerian agricultural activities largely depend on nature for irrigation and sunlight, with the long periods of drought resulting in the increasing temperature is a major setback to the ginger farmers. The above problem necessitated this study on the macroeconomic and climatic variables affecting ginger productivity in Nigeria for a period of 1961 – 2016.

2. LITERATURE REVIEW

Macroeconomic variables are products of monetary, fiscal and financial policies when implemented, such variables are exchange rate, interest rate, tax rate, tariff and gross domestic product. Macroeconomic variables have serious economic and developmental implications for agricultural productivity and simulation of exports. There are so many literature to support the impact of macroeconomic variables on the productivity of agriculture. Coa and Birchenall (2013) found that agricultural productivity contributes immensely to the total factor productivity (TFP) of the non agricultural sector as the agricultural sector productivity triggers employment and reallocation of output. Memon et al; (2008) revealed the existence of long-run relationship between agricultural output and exports. Ali et al; (2010) examined the relationship between some macroeconomic variables and agricultural income in Malaysia, adopting the Johansen co-integration approach with some key macroeconomic variables having both positive and negative impacts. In Nigeria, Garba (2000) and Akpokodje (2000) confirmed that major macroeconomic variables changes result in agricultural policy instability. Awokuse (2005) found that the changes in monetary supplies have a relatively low impact on agricultural produce price. Oluwatayese et al; (2016) adopted the vector error correction model to analyze the macroeconomic factors and the agricultural sector in Nigeria, the study revealed the existence of a long-run relationship between the variables. While Shariff (2015) adopted the autoregressive distributed lag approach to determine the existence of a long-run relationship between macroeconomic variables and the agricultural productivity in Malaysia.

Climate variables are factors that determine the climate of a region, usually measured for a period of thirty years or more. The major variables include rainfall/ precipitation and temperature/ the sunshine. Though there are limited recent literature on the impacts of climate variables on the agricultural productivity, some related ones were reviewed. In determining climate effects on US total agricultural productivity, Lang et al; (2017) adopted the TFP in measuring productivity while examining its relationship with temperature and precipitation. Ayinde et al;(2011) adopted the Johansen co-integration technique in estimating the effects of climate variables on agricultural productivity, the study revealed that rainfall and temperature exerted positive and negative effects on agriculture respectively. Chukwunonso (2015) adopted the error correction model in estimating the impact of temperature and rainfall on crop yield, forestry production, livestock production and fish production in Nigeria. Nwachukwu et al; (2012) in estimating climate change effects on cocoa productivity in Nigeria considered rainfall and temperature which were significantly affecting productivity. Mbanasor et al; (2015) and Nwajiuba & Onyeneke (2010) in estimating the impact of climate change on the productivity and yield of some crops in Nigeria revealed that temperature and precipitation were significant factors affecting their productivity using the log quadratic regression approach and ordinary least square regression approach respectively. Onwumere & Ichie (2012) and Howard et al; (2016) revealed that rainfall is a significant factor influencing cassava and wheat production respectively using error correction approach.

This study considered some key macroeconomic variables such as output, arable land, mechanization level, price, labour, fertilizer usage and capital. The major climate factors considered are rainfall and temperature. The autoregressive distributed lag model was adopted for this study.

3. METHODOLOGY

3.1. The Study Area

The study was carried out in Nigeria. Nigeria is a country located in West Africa along the Atlantic Ocean's Gulf of Guinea, its land borders are with Benin to the West Cameroon and Chad to the East and Niger to the North. It is between latitudes 40N and 140N and longitudes 30E and 150E Meridian. Nigeria's equatorial position gives its tropical climate but this does not mean a single environment. It has a tropical climate with relatively high temperatures throughout the year annual average temperature varying from 350c in the North to 310C in the south. Temperature is highest from February to April in the South and from March to June in the North and lowest in July and August over most of the country.

In fact, Nigeria is a country of diverse climates, landscapes, wildlife, cultures, and traditions. It is the most populous nation in Africa and has one of the fastest growing population in the world. The population of Nigeria is estimated at 158,000,000 people and growing at 2.45%, according to the 2010 CIA world factbook. And by this, Nigeria was ranked number 8 world's most populous nations in 2010. Currently, the population of Nigeria is being put at 167,000,000 people. It is being estimated that Nigeria will be ranked 4th by 2050 as the world most populous nations.

Nigeria is a powerhouse economically and politically in Africa, however, its large population experience everything from extreme wealth and comfort to stark poverty and hardship, Nigeria also has a diverse landscape ranging from tropical rainforests to dry savannah lands.

Nigeria has a land area of about 923,769km2 (FOS, 1989), a north-south length of about 1450km and west-east breath of about 800km. its total land boundary is 4047km while the coastline is 853km. The 1993 estimate of irrigated land by the federal ministry of environment of Nigeria was 9570 km2 and arable land is 35%, 15% pasture; 10% forest reserve; 10% for settlement and the remaining 30% considered uncultivable. (Boomie, 1998; Cleaver and Shreiber, 1994). Nigeria water bodies consist of an area of about 13,000 sq. km while the remaining land is about 910,769sq km.

Nigeria enjoys the humid tropical climate with two clear identifiable seasons, the wet and dry seasons. The climate condition varies among regions: equatorial in the south, tropical in the center and arid in the north. It is a country of marked ecological diversity and climatic contrast. Nigeria has a population of over 173.6 million people (NBS, 2013), with diverse biophysical characteristics, ethnic nationalities (more than 250), agro-ecological zones and socio-economic conditions. Farming is the predominant occupation of the people; about half of the working population is engaged in agriculture, the majority of who are smallholder farmers. Cassava, yam, sorghum, maize, millet, and rice are among the major food and cereal crops in Nigeria. The country has been warned against food scarcity and famine in 2017 (FAO, 2017).

3.2. Data Source and Collection Procedure

This study adopted principally secondary data obtained from the Central Bank of Nigeria statistical bulletin, National Bureau of Statistics (NBS), Food and Agriculture Organization database, World Bank Statistical Bulletin, statistical reports and other sources for a period of 1961-2016.

3.3. Method of Data Analysis

3.3.1. Analytical Procedures

Unit Root Test using the ADF test, and Philip-Perron technique to test if the time series data is stationary, the tests was done one by one for confirmation of the presence of constant means. Malmquist productivity a Autoregressive Distributed Lag (ARDL) model was adopted.

3.3.2. Model Specification

3.3.2.1. Unit Root Test: Augmented Dickey-Fuller (ADF) Test (for stationary test)

The ADF test consist of estimating the following regression

ΔYt = β1 + β1 + δYt-1 + Σmt=1 iΔYt-1 + et .... (1)

Where

y is the series t is trend factor,

et is the stochastic error term

t-1 is the lag length.

It is a one-sided test whose null hypothesis is δ=0 versus δ<o (hence large negative values of the test statistics lead to the rejection of the null) and Δ is the difference operator. Under the null, Yt must be differenced to achieve stationarity; under the alternative, Yt is already stationary and no differencing is required.

The Augmented Dickey-Fuller (ADF) unit root test was employed to test the integration level and the possible integration of the variables.

3.3.2.2. Unit Root Test: Philip Perron (PP) Test (for stationary test)

Consider a model

$$Y_t = \theta_0 + \phi Y_{t-1} + a_t \qquad \text{.... ....} \quad (2)$$

$$PP \text{ test equation} : \Delta Y_t = \theta_0 + \delta Y_{t-1} + a_{t\$} \text{ ....}(3)$$

Add a correction factor to the DF test statistic. (ADF is to add lagged ΔYt to 'whiten' the serially correlated residuals)

The hypothesis to be tested:

$$H_0 : \delta = 0$$
$$H_1 : \delta < 0$$

3.3.2.3. Malmquist Productivity Index Measure Of Total Factor Productivity

This study adopted the Malmquist Productivity Index measure of Total factor productivity using Data envelopment analysis (DEA) following Ajetomobi (2009). It is possible using the Malmquist input-focused productivity index to decompose this total productivity change between the two periods into technical change and technical efficiency change. Following Export, Grosskopf, and Lovell (1994), the input-based Malmquist productivity change index may be formulated as:

$$M_o(x^t, Y^t, x^{t+1}, Y^{t+1}) = \left[\frac{d^t(x^{t+1}, Y^{t+1})}{d^t(x^t, Y^t)} \frac{d^{t+1}(x^{t+1}, Y^{t+1})}{d^{t+1}(x^t, Y^t)} \right]^{1/2}$$

Where the subscript o indicates an input-focus, M is the productivity of the most recent production point (xt+1, Yt+1) (using period t + 1 technology) relative to the earlier production point (xt, Yt) (using period t technology), D are input distance functions, A value greater than unity will indicate positive total factor productivity growth between the two periods. y is the output of each of the root and tuber crops while x is the input. Following Export, Grosskopf, Lindgren and Roos (1992) an equivalent way of writing this index is:

$$Ms_o^{t+1}(\Re^t, s^t, \Re^{t+1}, s^{t+1}) = \frac{d^{t+1}(\Re^{t+1}, s^{t+1})}{d^t(\Re^t, s^t)} \left[\frac{d^t(\Re^{t+1}, s^{t+1})}{d^{t+1}(\Re^{t+1}, s^{t+1})} \frac{d^t(\Re^{t+1}, s^{t+1})}{d^{t+1}(\Re^t, s^t)} \right]^{1/2} \ldots\ldots\ldots \quad (5)$$

M = $E * P$

$\Re = g + c + n + z + e$ ….. ….. (6)

Where

$\Re = g + c + b + z + e$

E= $\dfrac{d^{t+1}(\Re^{t+1}, y^{t+1})}{d^t(\Re^t, y^t)}$ ….. ….. (7)

P= $\dfrac{d^t(\Re^{t+1}, y^{t+1})}{d^{t+1}(\Re^{t+1}, y^{t+1})} \dfrac{d^t(\Re^{t+1}, y^{t+1})}{d^{t+1}(\Re^t, y^t)}$ ….. ….. (8)

3.3.2.4. Autoregressive Distributed Lag (ARDL)

Autoregressive distributed lag (ARDL) framework by Pesaran and Shin (1995, 1999), Pesaran et al. (1996) and Pesaran (1997) to establish the direction of causation between variables. This approach is used when dealing with large set of variables which their level of integration may be purely I(0), purely I(1) or mixture of both, which means that the test on the existence relationship between variables in levels is applicable irrespective of whether the underlying regressors are purely I(0), purely I(1) or mixture of both (Duasa, 2006).

Basically, the ARDL approach to cointegration (Pesaran et al., 2001) involves estimating the conditional error correction (EC) version of the ARDL model.

The F test will be used for testing the existence of the long-run relationship. When a long-run relationship exists, F-test indicates which variable should be normalized. The null hypothesis for no cointegration among variables in equation (1) is H0: δ1 = δ2 = δ3 = δ4 =...= δn =0 against the alternative hypothesis H1: δ1 ≠ δ2 ≠ δ3 ≠ δ4 ≠...≠ δn ≠ 0. The F-test has a non-standard distribution which depends on (i) whether variables included in the model are I(0) or I(1), (ii) the number of regressors, and (iii) whether the model contains an intercept and/or a trend. The test will involve asymptotic critical value bounds, depending on whether the variables are I(0) or I(1) or a mixture of both. Two sets of critical values are generated which one set refers to the I(1) series and the other for the I(0) series. Critical values for the I(1) series are referred to as upper bound critical values, while the critical values for I(0) series are referred to as the lower bound critical values.

If the F test statistic exceeds their respective upper critical values, we can conclude that there is evidence of a long-run relationship between the variables regardless of the order of integration of the variables. If the test statistic is below the upper critical value, we cannot reject the null hypothesis of no cointegration and if it lies between the bounds, a conclusive inference cannot be made without knowing the order of integration of the underlying regressors.

If there is evidence of long-run relationship (cointegration) of the variables, the following long-run model is estimated:

$$\left[\begin{array}{l} \Delta(Ms_o)_t = \alpha_0 + \sum_{i=1}^{p}\phi_i\Delta(Ms_o)_{t-i} + \sum_{i=0}^{p}\theta_i\Delta(z)_{t-i} + \sum_{i=0}^{p}\lambda_i\Delta(c)_{t-i} + \sum_{i=0}^{p}\varphi_i\Delta(g)_{t-i} \\ + \sum_{i=0}^{p}\varphi_i\Delta(e)_{t-i} + \sum_{i=0}^{p}\varphi_i\Delta(h)_{t-i} + \sum_{i=0}^{p}\varphi_i\Delta(p_s)_{t-i} + \sum_{i=0}^{p}\varphi_i\Delta(r)_{t-i} + \sum_{i=0}^{p}\varphi_i\Delta(J)_{t-i} \\ + u_t \end{array}\right] [\ldots\ldots\ldots (9)]$$

The orders of the lags in the ARDL model are selected by either the Akaike Information criterion (AIC) or the Schwarz Bayesian criterion (SBC) before the selected model is estimated by ordinary least squares. For annual data, Pesaran and Shin (1999) recommended choosing a maximum of 2 lags. From this, the lag length that minimizes SBC is selected.

The ARDL specification of the short-run dynamics can be derived by constructing an error correction model (ECM) of the following form:

$$\left[\begin{array}{l} \Delta(Ms_o)_t = \alpha_2 + \sum_{i=1}^{p}\phi_{2i}\Delta(Ms_o)_{t-i} + \sum_{i=0}^{p}\theta_{2i}\Delta(z)_{t-i} + \sum_{i=0}^{p}\lambda_{2i}\Delta(c)_{t-i} + \sum_{i=0}^{p}\varphi_{2i}\Delta(g)_{t-i} \\ + \sum_{i=0}^{p}\varphi_{2i}\Delta(e)_{t-i} + \sum_{i=0}^{p}\varphi_{2i}\Delta(h)_{t-i} + \sum_{i=0}^{p}\varphi_{2i}\Delta(p_w)_{t-i} + \sum_{i=0}^{p}\varphi_{2i}\Delta(r)_{t-i} + \sum_{i=0}^{p}\varphi_{2i}\Delta(J)_{t-i} \\ + \psi ECM_{t-1} + \vartheta_t \end{array}\right] \ldots\ldots\ldots [10]$$

Where ECMt-1 is the error correction term, defined as the inverse of the equations

Where

s= output of ginger in tonnes
g= agricultural labour (number)
c=capital to agriculture (Naira)
z= land for agriculture (km)
e=machines and tractor (number)
n= fertilizer and chemicals (kilograms per hectare of arable land)
r= Annual mean Precipitation (mm)
J= Annual mean temperature (°c)
M = Malmquist productivity index

Δ= Difference operator
Y= dependent variables
x= independent variables
t= time
In= natural log
$\sum$ = summation sign
ECM = Error correction term
u, ϑ_t = error term are independent identically distributed.
$\delta, \phi, \theta, \lambda, \varphi$ = the coefficients
^{P}= lag operator
r = percentage growth in total world exports from period

4. RESULTS and DISCUSSIONS

4.1. Unit Root Test of the Variables

Prior to using the time series data for analysis, the variables were subjected to a stationary test using Augmented Dickey - Fuller test (ADF) and Philips-Peron test for confirmation and to ascertain the order of integration of the variables. The unit root test attempts to determine whether a given time series data is consistent with a unit root process. The presence of unit roots could lead to false inferences in regression between time series. From the results of the unit root tests presented in Table 1, most of the variables were stationary at first difference. Variable such as labour was not integrated while temperature was stationary at level.

The coefficients compared with the critical values revealed that all the variables were stationary at the level, first and second difference and on the basis of this; the null hypothesis of non-stationary were rejected and safe to conclude that the variables are stationary. This implied that the variables are integrated. If two or more series are individually integrated (in the time series sense), the individual series are first-order integrated (I(1)) but some (co integrating) vector of coefficients exists to form a stationary linear combination of them. The series may drift apart in the short-run, and then follow a common trend which permits a stable long-run relationship between them.

Since all the variables are not integrated in the same order, there is a need for a co-integration test. This implies that some linear combinations of the series must be co-integrated, such that even though the individual series may be integrated in the order I(0), I (1) or NI the series may drift apart in the short-run, and then follow a common trend which permits stable long-run relationship between them.

Table 1. Unit root test of the variables

	ADF test		Philips-perron		
	Level	1st difference	Level	1st difference	decision
capital to agriculture	3.361983	-4.27255	3.358728	-9.04731	I(1)
machinery	-4.29216	-5.22615	-4.84198	-6.61951	I(1)
Fertilizer	-2.20688	-7.05718	-2.60919	-9.19398	I(1)
agricultural labour	-0.82017	-2.32475	-1.84579	-2.05975	NI
Rainfall	-3.158	-7.94132	-4.60072	-12.2712	I(1)
Temperature	-5.56272	-9.63698	-6.40189	-13.5301	I(0)

Ginger malmquist index	1.208421	-2.70313	-4.99631	-33.444	I(1)
ginger area harvested	-2.02566	-4.28655	-2.15023	-6.67067	I(1)
ginger yield	-2.54288	-5.2862	-3.93792	-11.1609	I(1)
ginger production	-2.47609	-6.01019	-4.23896	-17.5268	I(1)
ginger producer price	-2.30249	-3.53121	-2.41523	-6.6858	I(1)

-4.1498, -3.5005 & -3.1793 are Mackinnon critical value for rejection of hypothesis of unit root applied at 1%, 5% & 10% respectively. I(0), I(1) & NI indicates that the variable has a constant mean at the level, first difference & not integrated respectively. Source: FAO database, World Bank development indicators, CBN statistical Bulletin various issues, UNDP climate data, Index Mundi, 2016 computed using Eviews 9.5

4.2. Level of Productivity (Malmquist Index) of Ginger

The result of the Malmquist productivity of ginger which is a function of ginger output and inputs such as land, capital, labour, machines and fertilizer; Table 2 presents the mean of the index using a 7 years range. The result indicates that productivity of ginger has been increasing marginally over the years. The mean stood was 0.0008 from 1989 – 1995 and 0.004 from 2010 – 2016.

Table 2. Malmquist productivity index for ginger

	range	mean
1961 - 1967	1.00717E-07	2.01543E-06
1968 - 1974	1.18769E-07	1.81456E-06
1975 - 1981	2.17959E-06	2.14045E-06
1982 - 1988	0.000301173	0.000179215
1989 - 1995	0.000374326	0.000881437
1996 - 2002	0.000177861	0.00133267
2003 - 2009	0.000537043	0.00182397
2010 - 2016	0.00355363	0.00404856

Source: FAO database and Index Mundi, 2016 computed using Ms. Office Excel 2010 and Gretl

Figure 1 illustrates the trend of ginger productivity which shows that the trend of ginger productivity became significant from 1981 and experiences a big ditch around 2014 which could be attributed to the incessant crisis in areas known for ginger production (Omobuwajo, 2015).

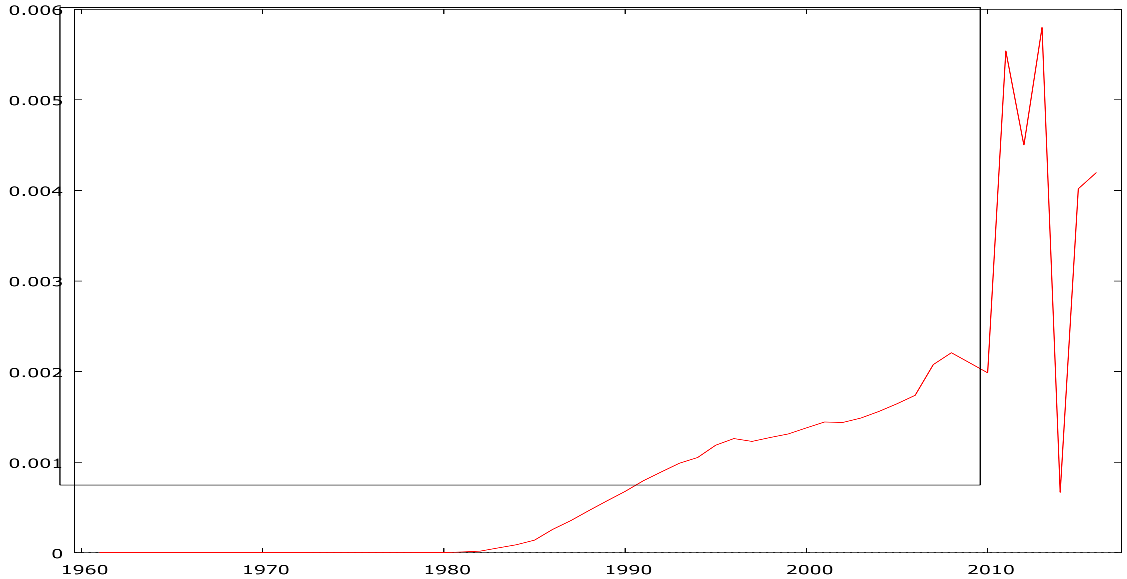

Figure 1: Malmquist productivity index trend for ginger
Source: FAO database and Index Mundi, 2016 computed using Gretl

4.3. Long Run and Short-Run Macroeconomic and Climatic Determinants of Ginger Productivity

The long run and short run determinants macroeconomic and climate determinants of ginger productivity, having conducted the unit root test autocorrelation tests using Breush-Godfrey serial correlation test.

4.4. Long-run Macroeconomic and Climatic Determinants of Ginger Productivity

With the value of the F-statistics was found to be statistically insignificant which implies that we accept the null hypothesis of no serial correlation in the long run determinants of ginger productivity model estimated as presented in Table 3.

Table 3. Breusch-Godfrey Serial Correlation LM Test: long run determinants of ginger productivity

F-statistic	1.008585	Prob. F(2,12)	0.3937
Obs*R-squared	7.339262	Prob. Chi-Square(2)	0.0255

Source: FAO database Source: FAO database, World Bank development indicators, CBN statistical Bulletin various issues, UNDP climate data, Index Mundi, 2016 computed using Eviews 9.

From Table 4 the Akaike Info Criterion(AIC) and the Schwarz criterion values of -16.945 and -15.534 which was minimal resulting in the selection of 4 lag lengths. The Durbin-Watson value of 1.979 confirms that the model is free from auto-correlation. The calculated F-statistics (F-statistic = 672.349), showing that the null of no cointegration can be rejected at 1.0 percent level as it was observed from the bound test that there is long run relationship running among the variables. This implies that there exists a long-run relationship or co integration between ginger productivity and its determinants. The result indicates that the long run overall model is well fitted as the independent variable explained over 99% (R2) movement in the dependent variable.

Previous ginger productivity recorded previously had both positive and negative long-run impact on the ginger productivity. The result indicates that ginger productivity (-2) and (-4) was statistically significant at 5% and positively influencing the productivity of ginger in the long run while ginger productivity (-3) was statistically significant and negatively influencing ginger productivity in the long run.

Land availability and usage had both negative long-term impact on the productivity of ginger. Land available for ginger production in three previous years was statistically significant at 1% and positively influencing the long run productivity of ginger while Land available for ginger production in four previous years was statistically significant at 1% and negatively influencing the long run productivity of ginger. This result implies that usage of land previously have a negative or positive effect on the productivity of ginger depending on how well land is managed.

Capital available for agricultural activities for the previous years had both long run negative and positive impact on the ginger productivity. In the initial previous years capital was statistically significant at 1% and 5% for 1st and 3rd lag respectively and negatively influencing the long run productivity of ginger. While for the 4th lag of the ginger productivity was statistically significant at 5% and positively influencing ginger productivity. This result implies that in the long run, the management of capital meant for agriculture in reflects on the long run productivity. Low funding is a technical issue face by Nigerian agriculture generally, the way funds are allocated are more problematic than in mobilizing them (Hallam & Willebois, 2013).

Fertilizer application was observed to have a long-term positive and negative impact on the long run productivity of ginger. Fertilizer application in the 1st, 2nd, and 3rd lag were all statistically significant at 1% and negatively influencing the long run productivity of ginger. This clearly shows that fertilizer application had a strong negative influence on the long-term productivity of ginger. With the 4th lag been statistically significant at 10% and positively influencing the ginger productivity, it, therefore, means that the influence of fertilizer application can either be negative or positive depending on the application procedures. Access to fertilizer is often subject to small holder farmers joining groups that engage in producing cash crops in hydro- agricultural developed areas. Fertilizers are often purchased on credit at a very high cost (Elhehri et al., 2013)

Previous rainfall was statistically significant at 10% and positively impacting on the productivity of ginger in Nigeria. This implies that rainfall contributed to the growth of ginger productivity over the period of the study.

The temperature of the last two years and three years were significant at 10% respectively and negatively influencing the productivity of ginger in long run. This implies that with the changing climate highlighted with the rising temperature poses a long run negative shock to ginger productivity.

The price of ginger in previous years was significant at 1% respectively and they are negatively influencing ginger productivity in the long run. This implies that ginger is not well priced resulting in the long-run reduction in the productivity of ginger. Obinatu (2003) made a similar observation in the study ginger marketing in Kaduna State, Nigeria.

Labour available for cassava production for the previous year statistically significant at 10% and negatively influencing the long run productivity of ginger, the implication of this result is that labour available for production in Nigeria which is mostly unskilled results to a large extent the long run decrease in the productivity of ginger in Nigeria (Bientema et al., 2012).

Table 4. Long run determinants of ginger productivity

Variable	Coefficient	Std. Error	t-Statistic	Level of significance
C	4.85E-05	7.40E-05	0.656106	
D(ginger productivity(-1))	0.136842	0.097893	1.397882	
D(ginger productivity(-2))	0.280014	0.077848	3.596916	**
D(ginger productivity(-3))	-1.314131	0.155323	-8.460624	***
D(ginger productivity(-4))	0.413812	0.086384	4.790381	***
D(Land(-1))	5.42E-10	1.49E-09	0.364020	

D(Land (-2))	1.86E-09	2.70E-09	0.688424	
D(Land (-3))	9.84E-09	2.41E-09	4.080033	***
D(Land (-4))	-1.42E-08	3.16E-09	-4.480153	***
D(capital(-1))	-1.46E-08	2.68E-09	-5.449580	***
D(capital (-2))	-1.82E-10	1.47E-09	-0.123948	
D(capital (-3))	-9.09E-09	3.57E-09	-2.543925	**
D(capital (-4))	1.49E-08	6.57E-09	2.261797	*
D(Machines(-1))	1.30E-07	1.69E-07	0.767689	
D(Machines (-2))	9.60E-08	9.93E-08	0.966273	
D(Machines (-3))	-2.40E-07	1.52E-07	-1.577515	
D(Machines (-4))	1.87E-07	1.36E-07	1.379839	
D(Fertilizer(-1))	-0.000305	4.57E-05	-6.666536	***
D(Fertilizer (-2))	-0.000105	2.77E-05	-3.788731	***
D(Fertilizer (-3))	-0.000361	4.39E-05	-8.224827	***
D(Fertilizer (-4))	0.000113	4.15E-05	2.722311	**
D(Rain(-1))	3.69E-06	1.86E-06	1.983206	*
D(Rain (-2))	3.99E-06	2.47E-06	1.611989	*
D(Rain (-3))	1.67E-06	2.79E-06	0.597248	
D(Rain (-4))	6.59E-07	1.89E-06	0.349448	
D(Temperature(-1))	-2.98E-05	3.28E-05	-0.907954	
D(Temperature (-2))	-7.13E-05	4.32E-05	-1.648766	*
D(Temperature (-3))	-7.95E-05	4.63E-05	-1.718439	*
D(Temperature (-4))	-6.29E-05	4.22E-05	-1.489285	
D(Price(-1))	-1.26E-09	1.51E-09	-0.838649	
D(Price(-2))	-6.29E-09	1.13E-09	-5.588339	***
D(Price(-3))	-7.03E-09	1.94E-09	-3.632116	***
D(Price(-4))	-1.01E-08	2.16E-09	-4.694108	***
D(Labour(-1))	-6.88E-10	3.88E-10	-1.772683	*
D(Labour (-2))	5.62E-10	6.47E-10	0.869428	
D(Labour (-3))	-2.87E-10	5.72E-10	-0.500503	
D(Labour (-4))	3.12E-10	3.92E-10	0.796553	

R-squared	0.999422	Mean dependent var	8.23E-05
Adjusted R-squared	0.997935	S.D. dependent var	0.001029
S.E. of regression	4.68E-05	Akaike info criterion	-16.94515
Sum squared resid	3.06E-08	Schwarz criterion	-15.54363
Log likelihood	469.1013	Hannan-Quinn criteria.	-16.40959
F-statistic	672.3490	Durbin-Watson stat	1.978605
Prob(F-statistic)	0.000000		

*,**& *** indicates that the values are significant at 10%, 5% & 1% respectively.
Source: FAO database Source: FAO database, World Bank development indicators, CBN statistical Bulletin various issues, UNDP climate data, Index Mundi, 2016 computed using Eviews 9.

Figure 2 presents estimate the CUSUM stability test in autoregressive distributed lags method (ARDL) for the long run determinants of ginger productivity to show the stability of the model. Our variables, data are stable because the cumulative sum of recursive residuals CUSUM graph is within the limits of 5% significance level.

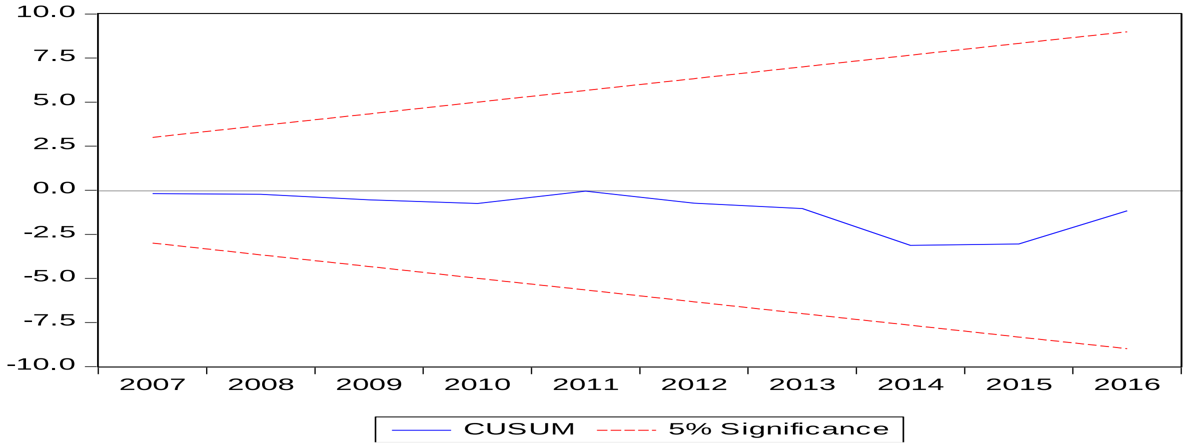

Figure 2:2 cumulative sum control chart for long run determinants of ginger productivity
Source: FAO database Source: FAO database, World Bank development indicators, CBN statistical Bulletin various issues, UNDP climate data, Index Mundi, 2016 computed using Eviews 9.

4.5. Short-Run Macroeconomic and Climatic Determinants of Ginger Productivity

With the value of the F-statistics was found to be statistically insignificant which implies that we accept the null hypothesis of no serial correlation in the short run determinants of ginger productivity model estimated as presented in Table 5.

Table 5. Breusch-Godfrey Serial Correlation LM Test: short run determinants of ginger productivity

F-statistic	1.778459	Prob. F(20,13)	0.1445
Obs*R-squared	38.81405	Prob. Chi-Square(20)	0.0070

Source: FAO database Source: FAO database, World Bank development indicators, CBN statistical Bulletin various issues, UNDP climate data, Index Mundi, 2016 computed using Eviews 9.

From Table 6 the Akaike Info Criterion(AIC) and the Schwarz criterion values of -12.074 and -11.330 which was minimal resulting in the selection of 2 lag lengths. The Durbin-Watson value of 1.946 confirms that the model is free from auto-correlation. The calculated F-statistics (F-statistic = 9.309), showing that the model is statistically significant. The result indicates that the long run overall model is well fitted as the independent variable explained over 84.3% (R2) movement in the dependent variable. The speed of adjustment from the short term to the long term (ECM) was statistically significant at 1% and suggests a high speed of adjustment from short term to long term.

The ginger productivity of the previous seasons (-1) and two previous seasons (-2) was significant at 1% and positively influencing the productivity of cassava in the short run. This implies that the ginger productivity recorded previously affected the current productivity positively i.e. the increase recorded in the previous years have a positive short-run impact on the productivity. The increase in the productivity is recorded gradually as an increase in technology and other inputs currently will lead to further increase in production.

Land available for ginger production in three previous years was statistically significant at 1% and positively influencing the short run productivity of ginger. This result implies that usage of land previously have a negative or positive effect on the productivity of ginger depending on how well land is managed. With the depreciating soil fertility and availability of arable land for the cultivation of ginger the productivity of ginger is affected negatively (Soule, 2013).

The capital was statistically significant at 1% and positively influencing the ginger productivity. This result implies that availability of capital results to the short run increase in ginger productivity.

Previous five years rainfall was statistically significant and negatively impacting on the productivity of ginger in Nigeria. This negative shock from rainfall indicates that rainfall has not been enough and this affects the ginger productivity in the short run.

Labour available for ginger production for the previous year statistically significant at 5% and negatively influencing the short run productivity of ginger, the implication of this result is that labour available for production in Nigeria which is mostly unskilled results to a large extent the short-run decrease in the productivity of ginger in Nigeria.

Table 6. Short run determinants of ginger productivity

Variable	Coefficient	Std. Error	t-Statistic	Level of significance
C	0.001101	0.000448	2.457729	*
D(ginger productivity(-1))	1.485211	0.251205	5.912346	***
D(ginger productivity (-2))	1.177426	0.186118	6.326237	***
D(Land(-1))	3.42E-09	5.60E-09	0.610935	
D(Land(-2))	1.62E-08	5.93E-09	2.736489	**
D(capital(-1))	4.50E-09	3.80E-09	1.183492	
D(capital(-2))	1.80E-08	3.63E-09	4.953636	***
D(Machines(-1))	6.56E-07	6.69E-07	0.979524	
D(Machines(-2))	1.89E-07	3.75E-07	0.503584	
D(Fertilizer(-1))	1.21E-05	9.78E-05	0.124004	
D(Fertilizer(-2))	-8.55E-05	0.000121	-0.705471	
D(Rainfall(-1))	-2.96E-05	1.21E-05	-2.434645	**
D(Rainfall(-2))	-1.42E-05	1.15E-05	-1.240378	
D(Temperature(-1))	0.000207	0.000226	0.915794	
D(Temperature(-2))	1.67E-05	0.000246	0.068101	
D(price(-1))	-6.20E-09	6.11E-09	-1.014814	
D(price(-2))	3.15E-09	7.39E-09	0.425895	
D(labour(-1))	3.40E-09	2.19E-09	1.551680	
D(Labour(-2))	-5.55E-09	2.02E-09	-2.749151	**
ECM(-1)	-2.630021	0.289841	-9.074005	***

R-squared	0.842762	Mean dependent var	7.92E-05
Adjusted R-squared	0.752230	S.D. dependent var	0.001009
S.E. of regression	0.000502	Akaike info criterion	-12.07381
Sum squared resid	8.33E-06	Schwarz criterion	-11.33030
Log likelihood	339.9559	Hannan-Quinn criteria.	-11.78789
F-statistic	9.309068	Durbin-Watson stat	1.946319
Prob(F-statistic)	0.000000		

*,**& *** indicates that the values are significant at 10%, 5% & 1% respectively.
Source: FAO database Source: FAO database, World Bank development indicators, CBN statistical Bulletin various issues, UNDP climate data, Index Mundi, 2016 computed using Eviews 9.

Figure 3 presents estimate the CUSUM stability test in autoregressive distributed lags method (ARDL) for the short run determinants of ginger productivity to show the stability of the model. Our variables, data are stable because the cumulative sum of recursive residuals CUSUM graph is within the limits of 5% significance level.

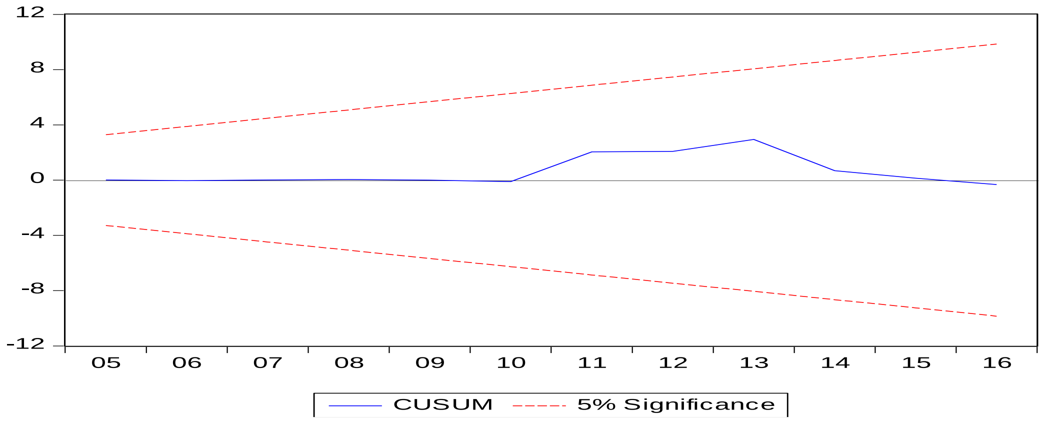

Figure 3:3 Cumulative sum control chart for short-run determinants of ginger productivity
Source: FAO database Source: FAO database, World Bank development indicators, CBN statistical Bulletin various issues, UNDP climate data, Index Mundi, 2016 computed using Eviews 9.

5. CONCLUSION

Ginger productivity in Nigeria is crucial topic of discourse owing to the economic importance of the crop for employment creation through value addition and as an important export earner. The impact of some climate related and economic variables on Nigeria ginger productivity in the long-run and short-run were estimated. The productivity of Nigeria ginger was observed to be increasing marginally despite some shortfalls. Temperature and rainfall had a long run negative and positive impact respectively on ginger production showing the strong influence of climate change. Capital had both positive and negative impacts on the productivity of ginger in the long run and short run. Fertilizer had both positive and negative impacts on the long run. The price of ginger had a negative long-run impact on the productivity of ginger. Labour had a negative long run and short run impact on the productivity of ginger while land for ginger farming had a short run positive impact. Based on the findings of this study several policy lessons can be learned which include the following

1. More effort should be put in the production of ginger as the past productions affect the future quantity produced.

2. Climate change mitigation and adaptation policies and programs should be put in place. Such program should directly affect smallholder ginger farmers for increases productivity i.e. there should be small holder farmer irrigation schemes to assist the smallholder in mitigating the ever increase temperature and reduction in the amount of rainfall.

3. Smallholder ginger farmers should be educated on the type and application of fertilizers. As fertilizer and chemical, usage is a significant determinant affecting the productivity of ginger in the long run and short run.

4. Price regulation by the government is essential for the productivity of ginger. Price is a significant determinant of ginger productivity both in the long run and short run.

5. Agricultural labour available in Nigeria is widely regarded as unskilled and insufficient for the agricultural production. Training and farming skills acquisition programs should be continuously done for the smallholder farmers especially using extension worker to educate the farmers.

6. Increased level of farm mechanization is required to increase the productivity of the root and tuber crops. A number of machines should be made available for sale and hire at a cheap cost to make the accessibility of machines high.

7. Availability and accessibility to more land with the basic input are essential for the increased production of root and tuber crops in Nigeria. The land tenure system in operation should be made flexible to enable ginger farmers access more land to enable mechanization and increased output.

8. The accessibility of capital to the root and tuber crops farmers should increase by making more capital available for loans and grants at a reduced interest rate.

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