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Effects of Climate Change, Poverty and Macroeconomic Policies on Agricultural Trade Performance in Nigeria

Anthony O. Onoja[1*] and A. I. Achike[2]

[1]Department of Agricultural Economics and Extension, University of Port Harcourt, Nigeria.
[2]Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author AOO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author AIA read and approved the final manuscript.

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ABSTRACT

Aims: This study ascertained the joint influences of climate factors, poverty and macroeconomic environment on agricultural export performance in Nigeria.
Study Design: The study is a survey based on time series data.
Place and Duration of Study: Secondary data covering 32 years (1978-2009) obtained from Central Bank of Nigeria's Annual Report and Statistical Bulletin and National Bureau of Statistics were used for the survey.
Methodology: The sample size was 32 (years) based on data availability. Data analysis was conducted using bound testing approach of co-integration advanced by Pesaran et al. [25] otherwise known as Autoregressive Distributed Lag (ARDL).model. Test for unit roots in the series were done at their levels and first differences using Augmented Dickey Fuller and Philips Perron tests before applying the ARDL model.
Results: Preliminary results from the ARDL model indicated that climate variability (variations in mean annual rainfall), gross fixed capital formation (proxy for wealth accumulated in the economy) and macroeconomic variables including interest rate and volume of domestic credit advanced to the private sector significantly influenced the performance level of agricultural export. However, on the long-run, macroeconomic factors (interest rate and credit to the private sector) and gross fixed capital of the economy (with p values of 0.01, 0.07 and 0.03 respectively were the most significant

**Corresponding author: Email: tonyojonimi@gmail.com;*

determinants of agricultural export trade performance in the country within the review period. On the short run, it was confirmed that gross fixed capital formation (wealth) Granger caused the level of agricultural export performance while agricultural export performance level Granger caused volume of domestic credit advanced to the private sector of the economy both with p values of 0.07.

Conclusion: It was recommended that macroeconomic policies aimed at increasing farm credit and reduction of interest rate should be strengthened; while programmes to build resilience to climate variability such as irrigation facilities and capacity building in climate change adaptation should be put in place by the Nigerian government.

Keywords: Agricultural export trade; poverty; macroeconomic policy; climate change; co-integration; Autoregressive Distributed Lag Modelling (ARDL model); Nigeria.

1. INTRODUCTION

Unarguably, commodity production and trade have become a significant factor on sustainable livelihoods of the poor, as well as on the export and growth performance of the vast number of commodity-dependent developing countries as Africa [1]. Unfortunately, the World Bank [2] indicated that the systemic information that is necessary to decompose the determinants of export growth for agriculture is very limited. The information exists only for manufacturing, it noted. Therefore country level studies about determinants of agricultural export trade performance, as this study attempts to model can contribute to this knowledge gap. According to UNCTAD [1], 50 percent of all developing countries depend on non-fuel commodities for more than half of their export earnings, two thirds if fuels are included. For some countries in Africa such as Nigeria, trade in non-oil commodities especially agricultural exports, constitutes a significant share of their economic growth [3]. The CBN report indicated that Nigerian domestic economy's growth rate of 7.9 percent as at 2010 which rose from 7.0 in 2009 was largely ascribed to sustained growth in non-oil sector and improvements in oil sector. Specifically, it noted that agriculture accounted for the greatest share of GDP growth rate as it contributed 2.4 percentage followed by services with 2.1 percent while whole sale and retail trade contributed 2.0 percent. It is therefore not surprising to note that in recent years, renewed interest in agriculture as a key propeller of development and poverty reduction has been witnessed [4].

African countries face many challenges to spur diversified agricultural growth and to gain from trade, despite the implementation of the Uruguay Round Agreement on Agriculture. These impediments include problem of climate change and its attendant effects on agriculture. However, in order to take advantage of new trading opportunities Africa needs to strengthen supply-side capability especially the agricultural supply sector. Unfortunately not much study is available to give evidence on the drivers of agricultural trade performance in Africa especially in Nigeria, a major contributor to African agricultural trade. Against the foregoing problems and research gaps this study was designed to find out the major determinants of agricultural supply and trade performance in Africa using Nigeria, the most populous country in Africa as a case study while focusing especially on the probable roles of poverty, climate factors and macroeconomic policy variables (such as interest rate), external influences (such as world price index of agricultural commodities) on agricultural trade in the study area. Results are expected to provide indices for evidence based planning that will facilitate agricultural trade, economic growth, boost food production and reduce food insecurity as well as poverty at the national and regional levels. The unique aspect of this study is its bold attempt to empirically establish the linkage between climate change (physical environmental factor), macroeconomic environment and wealth of a nation with agricultural trade using relatively new econometric approach (ARDL model). Outcome of a result of this type of study will give more lessons on broader approaches to tackling improving agricultural trade's contribution to economic growth placing much emphasis on physical and economic environment and poverty reduction as possible tools of intervention to attain this noble economic goal. Such lessons are not local but can apply to any country in the world.

1.1 Literature Review

The African leaders of the New Partnership for Africa's Development (NEPAD) under the Comprehensive Actions for African Agricultural Development, CAADP framework clearly were therefore justified when they indicated that among their priorities are infrastructure and agriculture which both have an interface. However there is also the need to check factors which could influence contribution of agriculture to growth. This is why IFAD noted that globally, increasing attention is being given both to issues of adaptation to climate change in smallholder agriculture and to ways in which poor rural people can participate in, and benefit from, market opportunities linked to environmental services and climate change mitigation [4] The issue of climate change becomes very daunting when one notes Easterling et al. [5]'s report that Sub-Saharan Africa is expected to face the largest challenges regarding food security as a result of climate change and other drivers of global change. Overall, Fischer et al. [6] estimated that as a result of climate change, agricultural GDP in Africa is expected to fall by between -2 to -8 percent (HadCM3 and CGCM2) and -7 to -9 percent (CSIRO model) [6]. This will significantly influence agricultural trade performance. Many farmers in Africa are likely to experience net revenue losses as a result of climate change, particularly as a result of increased variability and extreme events, the report added. There is broad agreement that growth in agriculture usually generates the greatest improvements for the poorest people – particularly in poor, agriculture-based economies. The IFAD report recognizes that agriculture, if better suited to meeting new environmental and market risks and opportunities facing smallholders can remain a primary engine of rural growth and poverty reduction. And this is particularly true in the poorest countries such as Sub-Sahara Africa. About 70 percent of Africans and nearly 80 percent of the continent's poor live in rural areas and depends mainly on agriculture for their livelihood. The sector accounts for about 20 percent of Africa's GDP [1], 60 percent of its labour force and 20 percent of the total merchandise exports (AU-NEPAD [1]). Agriculture is the main source of income for 90 percent of rural population in Africa [1]. Unfortunately however, it was observed by NEPAD [7] that the share of Africa in world agricultural exports has dropped steadily, from 8 percent in 1971-80 to some 3.4 percent in 1991-2000 and reversing this decline will require increased efforts by the African countries, with the assistance of the international community, to surmount the hurdles, including domestic supply-side constraints [7].

NEPAD [7] rightly noted that Africa faces trade challenges at many levels: The farmer faces non-remunerative markets and loses the incentive to produce; the nation-state fails to find rewarding markets both within the region and globally; Africa as a region is marginalized as well as being often uncompetitive in the international marketplace; furthermore, Africa continues to offer mostly unprocessed produce for which prices are static or falling, the report added. Responses to these issues pose challenges that NEPAD will need to address at the appropriate level.

There are diverse schools of thoughts about the relationship between poverty and agricultural trade performance in literature. Word Bank [2] indicated that a development strategy based on agricultural commodity exports was likely to be impoverishing in the prevailing agricultural policy environment in which policymakers in many countries had mercantilist and protectionist reflexes (that, when aggregated, compromise world trade in agricultural and food products). Morrissey et al. [8] corroborated earlier literature which supports the view that low income constrains the ability of households to buy or produce the products they need. The implication of this finding is that poverty can be a cause of market performance or market performance too can also be a source of poverty alleviation to farmers who export their crops. Morrissey et al. [8] stressed that a major factor in the reduction in rural poverty was the improved incomes and earnings from marketed agricultural produce. This, according to them was in part a reflection of trade policy reforms in crops with favorable world prices. The relevance of agriculture for poverty and the poor however is not limited to export crops. Greater importance than trade per se, however is the ability of farmers to respond to opportunities, in particular to substitute crops as relative prices change. This also have implications for increases or decrease in world price of agricultural export crops. Their rise internationally can send signals to farmers to export more. While evidence shows that farmers will respond to price incentives, it is also evident that they faced major constraints in doing so.

The World Bank [9] noted that world prices of agricultural commodity and economic growth of other countries outside Africa do impact positively on market performance of agricultural exports in Africa. Specifically, it indicated that the high commodity prices of recent years, coupled with Asia's rapid economic growth, have helped Africa expand its exports to Asia, which now imports 25 percent of all African exports. The growing economies of India and China alone account for 10 percent of Africa's exports. As these countries continue to grow and demand more natural resources, African exporters may be poised to increase revenues and expand their production in concert with the Indian and Chinese economic growth.

Diouf [10] posited that climatic adversities to a certain degree, civil unrest and war; access to markets for African agricultural products and unstable world prices adversely affected agricultural development in Africa in a serious way. They do and in particular international prices of primary commodities, he added. Some African exporters of agricultural products lost up to one third of their export earnings, due to the sharp decline in world prices and the duration of drought in the Sahel during the 1970s and 1980s was longer than anywhere else outside Africa. No economy, even a developed one can sustain such circumstances for a long period without having its social balance, which is the foundation of economic growth, profoundly disrupted. NEPAD [7] noted that adequate and well-functioning infrastructure was essential for agriculture to be competitive (market driven) due to reduced costs of delivering inputs to it and of taking produce out to markets, including any storage that this may entail; energy infrastructure is essential for development of agro-industries; information infrastructure is vital for timely technological information to farmers and agro-industrialists but also between producers and markets; water infrastructure is a precondition for irrigation for Africa.

Agricultural production depends on climate variables, such as temperature, precipitation, and ligh [11]. Hussler [12] found that agricultural production growth has been sensitive to rainfall variabilities and that this sensitivity has been modified across countries.

Research has shown that Sub-Saharan African agriculture is currently facing challenges in international trade with respect to external market access conditions and competition in world markets as a result of trade liberalization efforts under the world trade organization (WTO) agreements and in particular the agreement on agriculture (AoA). It has also been observed that the performance of agricultural exports from Sub Saharan Africa, based on production and value, for the period 1990 to 2000 showed mixed trends across countries and commodities [13]. In general, there has been an increase in production and exports of non-traditional commodities but exports of traditional exports for some countries show an increasing trend while for others they have stagnated or even declined due to declining world market prices and domestic marketing problems which may be as a result of macroeconomic policies. Macroeconomic reforms, including domestic and export subsidies in developed countries was therefore advocated [13] because they reduce the competitiveness of products from Sub Saharan Africa by depressing world market prices besides making it difficult for these countries to diversify their agriculture.

It has been indicated that improved access to international markets can contribute to the expansion of the external sector at all stages of its structural development but this seems to be relatively more important at the earlier stages of structural evolution than for countries that have already achieved a high degree of structural change [1]. This suggests that the more advanced developing countries are better able to exploit market opportunities through product diversification and differentiation for example by quality upgrading and thereby also avoiding trade barriers. The less advanced countries produce more homogeneous products that are more easily targeted by trade barriers (as well as suffering from commodity price declines), so that, when barriers come down, they experience a sharper increase in performance [1]. These findings have important implications for national policies and strategies, development cooperation programmes and actions within the trading system.

FAO [14] shows how poverty can reduce market performance in tropical countries such as Sub-Sahara Africa. FAO noted that most poor countries are located in the tropics, where the higher incidence of crop and livestock diseases and pests and excessive or inadequate rainfall are further factors compromising their ability to participate in global agricultural markets.

United States Agency for International Development, USAID [15] observed that despite steady economic growth since the return to civilian rule in 1999, 2004 per capita income in Nigeria was only $500 (in current U.S. dollars). USAID noted that in Nigeria, agricultural production and export performance have been poor and showed little sign of improvement. This was attributed to a multitude of factors: the overvalued currency and poor business climate discussed above, as well as poor policies specific to the sector, such as unfavorable domestic pricing policies. In the period 1999–2003, agricultural export growth rates fluctuated but the average rate of growth was –1 percent per annum for the five-year period. The value added per agricultural worker in Nigeria averaged $807 (in constant 1995 dollars) during the five years to 2003—significantly higher than the $250 average of LI-SSA or Ghana's $346 and considerably lower than Cameroon's $1,215. The growth of added value in agriculture is in line with regional benchmarks (4.1 percent compared to the LI-SSA 4.2 percent average), but is unlikely to be sustainable. According to the World Bank as cited in USAID [15], the driving factor has been increased land use rather than improvements in technology.

Aksoy [16] showed that developing countries, especially least-developed countries, face much higher trade-related costs than other countries in getting their products into international markets. Some of these costs may reflect institutional problems within the countries themselves, such as inefficient practices and corruption and these problems require a domestic policy response. But some costs also reflect weak transportation infrastructure in many countries and firms' lack of access to standard trade-facilitating facilities such as insurance and trade finance (which may include access to credit at affordable interest rates).

Marketing can be defined as getting the right product or service in the right quantity, to the right place, at the right time and making a profit in the process [17]. Effective marketing is a result of examining every aspect of your business and how it affects the consumer's end experience. It covers everything you will need to do in order to deliver your products and services to the consumer including research, planning, pricing, packaging, promotion, selling and distribution. Marketing involves supply of goods and services. Agricultural export is a component of aggregate supply in an economy. Supply theory holds that ceteris paribus, as price changes, quantity supplied will change (i.e. movement along the same supply curve) such that when factors other than price changes, supply curve will shift. The theory holds that determinants of the supply curve (shifters) include production cost, technology (e.g. use of tractors, irrigation technology and adoption of climate resilient technologies such as fertilizer use, crop rotation, reforestation, etc.), number of sellers (level of competitiveness), environmental factors (weather and climate), government policies, population and expectation for future prices [18].

1.2 Analytical Framework

According to Stocks and Watson [19] the estimation of a long-run relationship involving co-integrated variables has been the focus of a lot of recent papers. Many studies have reported alternative co-integrating vector estimators and their asymptotic properties [20,21]. Stocks and Watson [19] noted that the asymptotic properties are not affected by endogeneity or serial correlation if the estimators are properly corrected. However, the applied researcher does not usually have enough data to justify the application of asymptotic theory. For this reason it is important to consider the small-sample performance of alternative co-integrating vector estimators. On the one hand, the general result points to a large bias in small samples for any estimator that ignores short-run dynamics [22]. The error correction mechanism (ECM) estimator, which considers explicitly knowledge of the short-run dynamics has problems in terms of t-statistics far from their theoretical distributions. Past literature identified the following models as efficient estimations methods for estimating single equation co-integrated regression: Fully Modified OLS [23], Canonical Co-integration Regression developed by Park [24] and Dynamic OLS postulated by Saikkonem in 1992 and Stock and Watson in 1993 [24]. However, these models have been flawed on various grounds which are beyond the scope of our immediate discussion. Interested readers should consult [19,20,21,25]. The most recent co-integration approach for single equation modelling gaining popularity now is the bound co-integration approach proposed by Pesaran et al. [25]. This present study applied this model. More explanation of this model can be found at the methods section.

2. METHODOLOGY

2.1 Area of Study

Nigeria is the most populous country in Africa with a population estimated at 162,265,000 by mid-2011, population living below poverty line of $2 per day of 84 percent, Gross National Income per capita of US $2,070 and CO_2 emission rate of 0.4 metric tonnes per capita [26]. According to CBN [3] the GDP of Nigeria stood at about US$4.9 billion (N775.4 billion) at

1990 basic prices. There are credible reports of climate change effects in Nigeria [27,28,29,30].

For instance IFAD [31] 2003/04 Nigeria living standards survey indicated that states in the Sudan/Sahel region (which are more arid) than all other regions of Nigeria recorded the highest incidence of poverty, with about 80 per cent of the population described as poor. The Niger Delta region has also witnessed growing poverty over the last 20 years, owing mainly to negligence by Government at all three levels. In addition, environmental degradation, perpetrated by oil companies in particular has eroded the resource base, notably land and water, thereby constraining agriculture and fishery development. This situation is further compounded by incessant socio-economic conflicts and restiveness among young people, which have hampered development efforts and severely compromised the security of life and property [31]. Average rainfall hovers around 1282.2 mm varying from 500 - 1800mm. In 2007 agriculture contributed 42.08% to Nigerians GDP. Out of this figure, crops, livestock, forestry and fishing contributed 37.54%, 2.64%, 0.53% and 1.37% to the country’s economy respectively. Agricultural *Products* include cocoa, palm oil, yams, cassava, sorghum, millet, corn, rice, livestock, groundnuts, cotton. Crude oil export is the major source of revenue. Industry types include textiles, cement, food products, footwear, metal products, lumber, beer, detergents and car assembly [32].

2.2 Data Source and Methodological Framework

Secondary data, mainly time series data from Central Bank of Nigeria’s Annual Report and Statistical Bulletin containing data from National Population. Secondary data from World Bank Meta-files [33] were equally used. We purposively selected 1978 to 2009 i.e. a sample of 32 years for ease of accessing data that will cover all the variables or series within the period of study.

The series were tested for unit roots at their levels and first differences using Augmented Dickey Fuller and Philips Perron tests [34,35]. The results are presented in Appendix 1. When it was noted that some of the series were not I(0) but became stable at I(1) the researchers decided to apply the bound co-integration testing approach following Pesaran, et al. [25]. Standard econometric diagnosis were performed including Breusch- Godfrey serial correlation LM test, Jacque-Bera normality test and Ramsey RESET specification test following [37,36,35,34].

Granger pair wise causality tests were performed to ascertain the short run bi-directional causality of the statistically significant independent variables in relationship with the dependent variable. From the test of dynamic short-run causality presence among the relevant variables of the model, If the null hypothesis of no causality is rejected, then we conclude that a relevant variable Granger-caused agricultural export performance.

The use of the bounds technique is based on three validations. First, Pesaran et al. [25] advocated the use of the ARDL model for the estimation of level relationships because the model suggests that once the order of the ARDL has been recognised, the relationship can be estimated by OLS. Second, the bounds test allows a mixture of I(1) and I(0) variables as regressors, that is the order of integration of appropriate variables may not necessarily be the same. Therefore, the ARDL technique has the advantage of not requiring a specific identification of the order of the underlying data. Third, this technique is suitable for small or finite sample size [25].

Moreover, the bounds testing procedure [25] employed in this study is robust for small sample study. Furthermore, the bound testing approach is possible even when the explanatory variables are endogenous. The ARDL co-integration test, assumed that only one long run relationship exists between the dependent variable and the exogenous variables [25] (assumption 3). The bound test is basically computed based on an estimated unrestricted error-correction models (UECM) or error correction version of autoregressive distributed lag (ARDL) model, by Ordinary Least Square (OLS) estimator [25]. Basically, the bound test is the Wald test (F-statistic version of the bound testing approaches) for the lagged level variables in the right-hand side of UECM. That, we test the null hypothesis of non-co-integrating relation (Ho: $\delta_1= \delta_2= \delta_3=\ldots= \delta_n=0$) against the alternative hypothesis (H_A: $\delta_1\neq \delta_2\neq \delta_3\neq\ldots\neq \delta_n\neq 0$) (a long-run relationship exists). The computed *F*-statistic value will be evaluated with the critical values tabulated in table CI (iii) of Pesaran et al. [25]. According to these authors, the lower bound critical values assumed that the explanatory variables x_t are integrated of order zero or I(0), while the upper bound critical values assumed that x_t are integrated of order one or I(1). Therefore, if the computed *F*-statistic is smaller than the lower bound value, then the null hypothesis is not rejected and we conclude that there is no long-run relationship between agricultural export performance and its determinants. Conversely, if the computed *F*-statistic is greater than the upper bound value, then agricultural export performance and its determinants share a long-run level relationship. On the other hand, if the computed *F*-statistic falls between the lower and upper bound values, then the results are inconclusive. The researcher must conduct test to determine the order of integration before making a conclusive inference in this case.

Following Pesaran et al. [25,38] we assembled the vector autoregression (VAR) of order *p,* denoted VAR (*p*), for the following function:

$$Z_t = \mu + \sum_{i=1}^{p} \beta_i z_{t-i} + \varepsilon_t \tag{1}$$

where z_t is the vector of both x_t and y_t , where y_t is the dependent variable defined as agricultural export (agexport), x_t is the vector matrix which represents a set of explanatory variables i.e., trade openness (TOP), financial development (M2) and *t* is a time or trend variable. According to Pesaran et al [25], y_t must be I(1) variable but the regressor x_t can be either I(0) or I(1). We further developed a vector error correction model (VECM) as follows:

$$\Delta z_t = \mu + \alpha t + \lambda z_{t-1} + \sum_{i=1}^{p-i} \gamma_t \Delta y_{t-i} + \sum_{i=1}^{p-1} \gamma_t \Delta x_{t-i} + \varepsilon_t \tag{2}$$

where Δ is the first-difference operator. The long-run multiplier matrix λ as:

$$\lambda = \begin{bmatrix} \lambda_{YY} \lambda_{YX} \\ \lambda_{XY} \lambda_{XX} \end{bmatrix}$$

The diagonal elements of the matrix are unrestricted, so the selected series can be either I(0) or I(1). If $\lambda_{YY} = 0$, then *Y* is I(1). In contrast, if $\lambda_{YY} < 0$, then *Y* is I(0).

The vector error correction mechanism (VECM) procedures described above are compulsory in testing of at most one cointegrating vector between dependent variable y_t and a set of regressors x_t. To derive the model, postulations made by Pesaran et al. [25] in Case III, that is, unrestricted intercepts and no trends were followed.

The general co-integration hypothesis model can be stated as the following unrestricted error correction model (UECM):

$$\Delta\,(AGEXPORT)_t = \beta_0 + \beta_1(AGEXPORT)_{t-1} + \beta_2\,(lnRAINF)_{t-1} + \beta_3\,(lnWPIAGR) + \beta_4(lnINTR) + \beta_5\,(lnDOMCRPRIV) + \beta_6(lnGFC) + \beta_7\sum_{i=1}^{p}\Delta\,(AGEXPORT)_{t-1} + \beta_8\sum_{i=0}^{q}\Delta\,(lnRAINF)_{t-1} + \beta_9\sum_{i=o}^{r}\Delta\,(lnWPIAGR)_{t-1} + \beta_{10}\sum_{i=0}^{s}\Delta\,(lnINTR)_{t-1} + \beta_{11}\sum_{i=0}^{t}\Delta\,(lnDOMCRPRIV)_{t-1} + \beta_{12}\sum_{i=0}^{u}\Delta\,(lnGFC) + \varepsilon_t \quad (3)$$

Where Δ is the first-difference operator and ε_t is a white-noise disturbance term. Y = agricultural export performance also represented by AGEXPORT (market performance of agriculture measured in terms of agriculture trade as percentage of total trade), while hypothesized drivers of agricultural export trade performance include: X_1 = GFC or asset ownership (or poverty proxied by Gross fixed capital, formation in the economy in millions of naira per year, DOMCREPRIV (X_2) = domestic credit to the private sector of the economy (in millions of naira per annum), RAINF (X_3)= climate change (mean annual precipitation in Nigeria in mm), INTR (X_4) = interest rate (average ending rate per annum in percentage, WPIAGR (X_7) = world price of index agricultural commodities, while ε_t = stochastic error term. It refers to natural log of the respective variables raised to power e. β_0 … β_{11} are co-efficients of the respective variables.

Equation (3) also can be viewed as an ARDL of order (p, *q*, *r, s, t, u*). Equation (3) indicates that agricultural export performance tends to be influenced and explained by its past values. The structural lags are validated by using minimum Akaike's information criteria (AIC). Judging from the estimation of unrestricted error correction mechanisms (UECMs), the long-run elasticities are the coefficient of one lagged explanatory variable (multiplied by a negative sign) divided by the coefficient of one lagged dependent variable [39]. For example in equation (3), the long-run rainfall and world price of index agricultural commodities elasticities are (β_2 / β_1) and (β_3 / β_1) respectively. The short-run effects are explained by the coefficients of the first-differenced variables in equation (3).

3. RESULTS AND DISCUSSION

3.1 Determinants of Agricultural Export Trade in Nigeria

The starting point of our analysis was the consideration of the results of tests of stability of the models' series using ADF and PP tests. The details of these analyses are presented in Appendix 1 and 2. In summary, going by the ADF test statistics, it was found that only two series, rainfall level, was stable at levels (i.e. I(0)). Other variables or series became stable after the first differences (i.e. I(1). The performance of the series with respect to unit root tests was not too different when PP test was conducted. It was found that none of the series was stable at levels using the PP criterion. They all became stable in their first differences thus indicating that they were integrated in the order 1 (i.e. I(1).). Obviously, the mixture of both I(0) and I(1) variables would not be possible under the Johansen procedure. This gives a good justification for using the bounds test approach or ARDL model.

The estimation of Equation (3) using the ARDL model is reported in Table 1. Using Hendry's general-to-specific method, the goodness of fit of the specification, that is, R-squared and adjusted R-squared, is 0.76 and 0.60 respectively. The robustness of the model has been validated by several diagnostic tests carried out, such as Breusch- Godfrey serial correlation LM test, ARCH test, Jacque-Bera normality test and Ramsey RESET specification test. All the tests indicated that the model has the desirable econometric properties, it has a correct functional form and the model's residuals are serially uncorrelated, normally distributed and homoskedastic. Therefore, the results reported are serially uncorrelated, normally distributed and homoskedastic. The results reported are valid for reliable interpretations.

Table 1. Estimated model based on equation (3) dependent variable: AGEXPORT white heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Standard errors	t-statistics
Intercept	10.429	39.946	0.261
AGEXPORT(-1)	-0.561	0.268	-2.092*
D(AGEXPORT(-1))	-0.202	0.18	-1.127
lnRAINF(-1)	-5.375	6.199	-0.867
D(lnRAINF(-1))	8.466	3.113	2.720**
lnWPIAGR(-1)	-0.354	0.306	-1.156
D(lnWPIAGR(-1))	-0.27	1.144	-0.236
lnINTR(-1)	-2.723	1.028	2.649**
D(lnINTR(-1))	-1.58	0.764	-2.067**
lnDOMCREPRIV(-1)	2.464	1.298	1.899*
D(lnDOMCREPRIV(-1))	1.445	1.371	1.054
lnGFC(-1)	1.024	0.424	2.413**
D(lnGFC(-1))	0.001	0.446	0.002
R-squared	0.7	F-statistic	4..93***
Adjusted R-squared	0.507	Prob(F-statistic)	0.01

Table 2. Econometric diagnostic checks

Type of diagnositic test	*Coeff.*	*p Value*	*Remark*
Breusch-Godfrey Serial Correlation LM Test	2.073	0.16	Accept the null hypothesis of no presence of 2nd order serial correlation in the model
Jarque-Bera test	2.514	0.28	Accept the null hypothesis of residual coming from a normally distibiuted sample
Breusch-Pagan-Godfrey test for heteroscedasticity	1.322	0.28	Accept the null hypothesis of no heteroscedasticity in the model
Ramsey RESET Test (F test estimated at 1, 16 d.f.)	0.1188	0.73	Accept the null hypothesis that the correct specification is linear

Source: Analysis of CBN [32] and National Bureau of Statistics Data using EViews Package by Author

The estimation of Equation (3) using the ARDL model is reported in Table 1. Using Hendry's general-to-specific method, the goodness of fit of the specification, that is R-squared and adjusted R-squared is 0.70 and 0.50 respectively. The result implies that the model explained correctly 50 percent of the variation in the agricultural export trade performance model, which is a fairly good fitting, using the adjusted R-square criterion. The robustness of the model has been validated by several diagnostic tests such as Breusch- Godfrey serial correlation LM test, ARCH test, Jacque-Bera normality test and Ramsey RESET specification test (Table 2). All the tests disclosed that the model has the aspiration econometric properties, it has a correct functional form and the model's residuals are serially uncorrelated, normally distributed and homoskedastic. Therefore, the outcomes reported are valid for reliable interpretation and policy analysis.

In Table 3 the results of the bounds co-integration test demonstrate that the null hypothesis of no co-integration against its alternative of presence of co-integration is hereby rejected at the 10% significance level. The computed *F*-statistic of 4.93 is greater than the upper critical bound value of 4.78, thus indicating the existence of a steady-state long-run relationship among agricultural export trade performance indicator, mean annual rainfall, interest rate (lending rate), domestic credit volume advanced to the private sector of the economy, world price index of agricultural commodities and poverty level (gross fixed capital formation).

Table 4 indicates that lending rate (or interest rate), volume of loans advanced to the private sector, and poverty level (GFC) have a positive impact on agricultural export performance in Nigeria over the period in review. If there is one percent increase in volume of loans advanced to the private sector, agricultural export performance rate grows by approximately 4.40 percent; while a unit increase in gross fixed capital formation (or wealth increase) is accompanied by increase in trade performance in the economy by 1.82 percent. In terms of lending rate, a unit increase in this factor will be accompanied by a reduction in the rate of agricultural export performance by approximately 4.86 percent. These imply that macroeconomic variables are significant determinants of long run increase in agricultural export trade performance in Nigerian economy.

Table 3. Bounds test for co-integration analysis

Estimated F value	Lag	Bound critical values (unrestricted intercept no trend)*		
		Critical value	Lower Bound Value I(0)	Upper bound value I(1)
4.93	1	1%	7.41	8.37
		5%	4.98	5.73
		10%	4.04	4.78

**Based on Critical F values for conducting bound test for cointegration as cited in Pesaran et al. [25], in "Table C1.iii Case III, unrestricted intercept no trend"*

Table 4. Long-run estimated coefficient

Variable	Coefficient	P value
RAINFALL	-9.589NS	0.30
WPIAGR	-0.631NS	0.26
INTR	-4.858**	0.01
DOMCRPRIV	4.396*	0.07
GFC	1.826**	0.03
Intercept	18.605NS	0.80

*NS = "Not Significant", ****, ** and * indicate significance at 0.01, 0.05 and 0.10 level respectively*

The dynamic short-run causality among the relevant variables is shown in Table 5. From this test, we infer that gross fixed capital formation (or level of wealth of the nation) is statistically significant in Granger-causing agricultural trade performance in Nigeria at 10 percent significance level while volume of domestic credit advanced to the private sector in the economy over the period in review was significantly Granger caused by level of Nigerian agricultural export trade performance.

Table 5. Short-run causality test (Granger Pair wise causality Test F-statistic)

Null Hypothesis	Obs	F-statistic	P value
LNINTR does not Granger Cause AGEXPORT	31	0.334	0.56
AGEXPORT does not Granger Cause LNINTR		0.107	0.74
LNDOMCREPRIV does not Granger Cause AGEXPORT	31		4.17
AGEXPORT does not Granger Cause LNDOMCREPRIV			0.07*
LNGFC does not Granger Cause AGEXPORT	31	3.370	0.07*
AGEXPORT does not Granger Cause LNGFC		0.217	0.64

NB: (***) = figures are significant at p =<0.01; (**) = figures are significant at p =<0.05, and (= figures are statistically significant at p =<0. 10.*

4. CONCLUSION

This research has established, through appropriate time series econometric approach (co-integration analysis) that macroeconomic factors, wealth stock of the nation, climate and other environmental variables (especially rainfall level and arable land expansion) have significant influences on export trade performance of Nigerian agricultural sector. It would therefore suggest that proper policy mix that will reduce poverty for instance (economic empowerment policies such as provision of agricultural credit), proactive policies to adapt to deleterious effects of extreme weather or climate events (e.g. flood management, irrigation based farming etc) and proper management of the macroeconomic regulations can improve agricultural trade. Based on the above findings, it is hereby recommended that macroeconomic policies aimed at increasing farm credit and reduction of interest rate should be strengthened while programmes to build resilience to climate variability such as irrigation facilities and capacity building in climate change adaptation should be put in place by the Nigerian government.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX 1

Results of stationary tests using Augmented Dickey Fuller (ADF) Statistic

Variable	*ADF Value Before Differencing*	*ADF Value after differencing*	*Critical Value*	*Level of Integration*
agexport	-2.128862NS	-7.146375***	-2.963972	I(1)
Intrrt	-2.558349NS	-8.544426***	-2.960411	I(1)
Indomcred	1.005332NS	-3.943077***	-2.960411	I(1)
Inforex	-1.514146NS	-5.058507***	-2.960411	I(1)
Inpgfc	-2.112403NS	-5.115874***	-2.960411	I(1)
Inrainf	-3.507717***	n.a.	-2.960411	I (0)
Inwpiagr	-0.814151NS	-4.701954***	-2.960411	I(1)

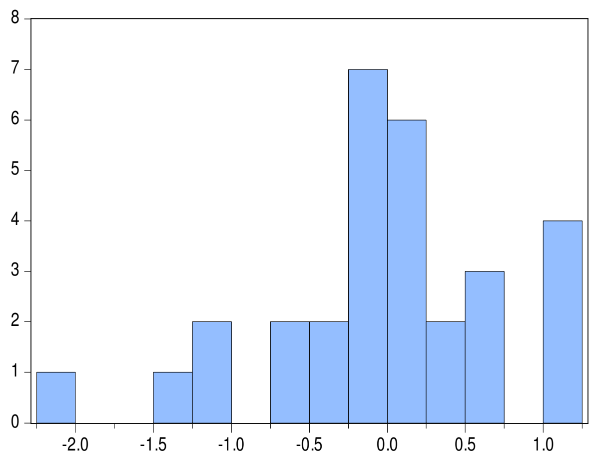
Source : Analysis of CBN (2011) and National Bureau of Statistics Data using EViews Package by Author

Appendix 2

Results of stationary tests using Philips Perron (PP) Statistic

Variable	*PP Value Before differencing*	*PP Value after differencing*	*Critical Value*	*Level of integration*
export	-2.163646NS	-7.080327***	-2.960411	I(1)
intrrt	-2.468201NS	-8.557680***	-2.960411	I(1)
Indomcred	1.005332NS	-3.921001***	-2.960411	I(1)
Inpovgfc	-2.161171NS	-5.125802***	-2.960411	I(1)
Inrainf	-3.472086NS	-9.085967***	-2.960411	I (0)
Inwpiagr	-0.822765NS	-4.674503***	-2.960411	I(1)

Source: Analysis of CBN (2011) and National Bureau of Statistics Data using EViews Package by Author



Series: Residuals	
Sample 3 32	
Observations 30	
Mean	2.59e-15
Median	0.029378
Maximum	1.110117
Minimum	-2.008937
Std. Dev.	0.741695
Skewness	-0.665593
Kurtosis	3.489512
Jarque-Bera	2.514596
Probability	0.284422

Fig. 1. Jarque-Bera test results

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.322244	Prob. F(12,17)	0.2915
Obs*R-squared	14.48288	Prob. Chi-Square(12)	0.2709
Scaled explained SS	5.788881	Prob. Chi-Square(12)	0.9263
Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	2.073554	Prob. F(2,15)	0.1603
Obs*R-squared	6.497757	Prob. Chi-Square(2)	0.0388

Breusch-godfrey serial correlation LM Test 2.073 (p = 0.160)

Ramsey RESET Test			
Equation: UNTITLED			
Specification: D(AGEXPORT) C AGEXPORT(-1)D(AGEXPORT(-1))			
LNRAINF(-1) D(LNRAINF(-1)) LNWPIAGR(-1) D(LNWPIAGR(-1))			
LNINTR(-1) D(LNINTR(-1)) LNDOMCREPRIV(-1)			
D(LNDOMCREPRIV(-1)) LNGFC(-1) D(LNGFC(-1))			
Omitted Variables: Squares of fitted values			
	Value	**df**	**Probability**
t-statistic	0.344769	16	0.7348
F-statistic	0.118866	(1, 16)	0.7348
Likelihood ratio	0.222049	1	0.6375
F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	0.117644	1	0.117644
Restricted SSR	15.95323	17	0.938425
Unrestricted SSR	15.83559	16	0.989724
Unrestricted SSR	15.83559	16	0.989724
LR test summary:			
	Value	df	
Restricted LogL	-33.09512	17	
Unrestricted LogL	-32.98409	16	

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