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Socio-Economic and Infrastructural Challenges Affecting the Competitiveness of Nigeria Soybean Production in International Trade: Auto-Regressive Distributive Lag Approach

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HIGHLIGHTS

- The ADR unit root test shows that ARE, RER are stationary at I (0) Level.
- The ADR unit root test shows that SOY, YED, and WOT were stationary at I (1) first difference.
- The ARDL reveals that ARE and YED are significant predictors influencing the competitiveness of soybean production in international trade.
- The speed of adjustment is at the rate of 86%.

Abstract

This research study examined the socio-economic and infrastructural challenges affecting the competitiveness of Nigerian soybean production in international trade: ARDL (Auto-Regressive Distributive Lag Approach). Data of secondary sources were used. The primary and secondary data were utilized for this study. The data covered the period of 2007 to 2022. Data were obtained from FAO, CBN, NBS, World Bank publication, and GHS-P. The econometric tools employed were descriptive statistics, ADF unit root test, and ARDL Model using STATA package. The outcome of ADF unit root test reveals that ARE and RER are stationary at I (0) (level), while SOY, YED, and WOT were stationary at I (1) (First difference). The ARDL employed for co-integration test for the time series data shows that the computed F- statistics of 13.69 is more than the value at upper bound value of 4.09 at the 5% level of significance, this connotes that there is long run association between the regressors in the model The estimated long-run outcome using ARDL show that ARE, YED are the significant

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regressors influencing the competitiveness soybean production in the international market The speed of regulation to where soybean will balance even when there is disequilibrium is at the rate of 86%. Policies that would stimulate the export of soybeans should be carried out, and research activities should be enhanced to improve the quality of the soybeans produced.

Keywords: Socio-economic and infrastructural challenges; competitiveness; Nigerian soybean; production; auto-regressive distributive lag model.

1. Introduction

Soybean (*Glycine max* L.) is a good source of vegetable oil, protein, and amino acids and can be used for soymilk, soy flour, soy dough, soy curd, and animal feed. Hence, soybeans are used for food, feed, oil, and fuel (Mohammed et al. 2016). Soybeans accounted for 35% of the total harvested area in the world devoted to perennial and annual crops. The soybean share in world oil-seed output is over 50% (Yusuf et al. 2022). The derivatives of soybean and soybean seed are the highly traded agricultural produce, which adjudges for about 10% of the total value of the world agricultural market (FAO 2015). The leading producers of soybeans are Brazil, China, the USA, and Argentina. In 2022 and 2021, Nigeria produced 1060000 metric tons and 1166050 metric tonnes of soybean, respectively (FAO 2024). In 2022, the area and yield of soybeans in Nigeria are 1100000 ha and 963.6 kg ha^{-1}, respectively (FAO 2024). In 2022, Nigeria's soybean export, soybean export value, and agricultural export values were 15,300 metric tons, 4,450,000 USD, and 1561.575 million USD respectively (FAO 2024).

Competitiveness at the macroeconomic level is established on the market shares for export (Umar 2020). The competitiveness is estimated as the soybean export value as a percentage of Nigerian agricultural export value. Adopting the model established by Yousif (2015), yield, area, and real exchange rate were the main factors of soybean competitiveness. Umar (2020) documented that agriculture's long-term competitiveness and progress are not associated with short-term regressors such as prices and input costs. For this purpose, the model does not consider price and interest rates. According to Ude et al. (2013) competitiveness can be explained as a comparative concept of the performance or potential of a firm country or sub-unit to sell and supply a commodity in a given market. Competitiveness explains whether a firm could successfully compete in international trade, given existing economic structures and policies (Ude et al. 2013). The comparative advantage can be described as the ability of one nation to produce agricultural produce at a lower opportunity cost of other produce forgone than another nation. Competitiveness as a competitive power is the potential to produce goods and services that meet the test of international trade, raise the welfare level of a country's citizens, and expand real income. In other words, competitiveness refers to a country's ability to produce, create, and distribute service products in the international market while raising the returns on its resources. From the perspective of competitiveness at the international level, a country should be able to raise real income and welfare by producing goods and services under fair international trade conditions (Nordin et al. 2008). The major objective is to estimate the socio-economic and infrastructural challenges affecting the competitiveness of Nigerian soybean production in the international market: ARDL approach.

The specific objectives are to (i) examine the summary statistics, e.g., skewness, kurtosis, and Jarque-Bera of the test predictors (ii) determine the stationarity and co-integration test of the test predictors, (iii) evaluate the factors influencing the competitiveness of Nigerian soybean production in international trade, and (iv) estimate the long run relationships of regressors influencing the competitiveness of Nigerian soybean production in the international market.

2. Methodology

This study was conducted in Nigeria. Primary and secondary data were used for this study. The primary data covered the period of 2007 to 2022. The data used were obtained from FAO (Food and Agriculture Organization), CBN (Central Bank of Nigeria), NBS (National Bureau of Statistics), World Bank publication, and (GHS-P) (General Household Survey-Panel) combined with Federal Ministry of Agriculture and Rural

Development. The econometric tools employed were descriptive statistics, ADF (Augmented Dickey-Fuller) unit root test, and ARDL (Auto-Regressive Distributive Lag) Model. Data were analyzed using inferential and descriptive statistics employing the STATA package as follows:

2.1 Summary statistics: This involves using skewness, kurtosis, Jarque–Bera, mean, and frequency distribution to have a summary statistic of the data.

2.2 The ADF model: The unit root test is carried out to determine the level of integration among predictors under examination. The ADF following Dickey and Fuller (1981) and Dickey and Wayne (1979) model is given as:

$$\Delta Y_t = \pi Y_{t-1} + \sum_{j=1}^{P} \gamma_j \, \Delta Y_{t-1} + \varepsilon_t \quad (1)$$

Were,

Δ = Symbol for the First Difference Operator,
π and γ_j = Parameter Estimates
ε_t = Error Term
Y_t = Time Series Data
P = Proxy for the Maximum Lag Length for the Regressor.

2.3 The ARDL: The model follows the work of Pesaran et al. (2001) described the ARDL model as very adjustable as it combines the short and long outcomes in a single equation.

2.4 The Model Specificatiom

The model in its implicit form is given as:

$$\text{SOY} = f(\text{ARE}, \text{YED}, \text{WOT}, \text{RER}, \text{GOP}, \text{CIF}, \text{TRB}, \text{SUP}, \text{ARF}, \text{DIF}) \quad (2)$$

Where,

SOY = The Share of Soybean Export Value as a Percentage of Nigerian Agricultural Export Value (%)
ARE = Area (Ha)
YED = Yield (Kg/ha)
WOT = World Trade in Oil Seed (Metric Tones)
RER = Real Exchange Rate (Naira per Dollar)
GOP = Government Policy (Interest Rate, Percentage)
CIF = Climatic Factors (Ranifall, mm),
TRB = Trade Barrier (Tariff, Naira),
SUP = Substitute Product (Sesame, tons)
ARF = Access Road to Farm (1, Access; 0, Otherwise)
DIF = Distant from Farm to Nearby Market (Km)

The Real Exchange Rate (RER) following Kingu (2014) is calculated as:

$$RER = \frac{CPI_{Nigeria}}{CPI_{USA}} \times NER \quad (3)$$

Where,

$CPI_{Nigeria}$ = Consumer Price Index of Nigeria

CPI_{USA} = Consumer Price Index of United States of America (US)

NER = The Nominal Exchange Rate in Local Currency($\text{₦}/\$$)

2.3 The Auto-Regressive Distributive Lag (ARDL) model is presented as follows:

$$\begin{aligned}\Delta \mathrm{SOY}_t = \alpha_0 &+ \sum_{i=1}^{k} \alpha_{1i}\Delta SOY_{t-1} + \sum_{i=1}^{k} \alpha_{2i}\Delta ARE_{t-1} + \sum_{i=1}^{k} \alpha_{3i}\Delta YED_{t-1} + \sum_{i=1}^{k} \alpha_{4i}\Delta WOT_{t-1} + \sum_{i=1}^{k} \alpha_{5i}\Delta RER_{t-1} \\ &+ \sum_{i=1}^{k} \alpha_{6i}\Delta GOP_{t-1} + \sum_{i=1}^{k} \alpha_{7i}\Delta CIF_{t-1} + \sum_{i=1}^{k} \alpha_{8i}\Delta TRB_{t-1} + \sum_{i=1}^{k} \alpha_{9i}\Delta SUP_{t-1} + \sum_{i=1}^{k} \alpha_{10i}\Delta ARF_{t-1} \\ &+ \sum_{i=1}^{k} \alpha_{11i}\Delta DIF_{t-1} + \gamma_1 SOY_{t-1} + \gamma_2 ARE_{t-1} + \gamma_3 YED_{t-1} + \gamma_4 WOT_{t-1} + \gamma_5 RER_{t-1} + \gamma_6 GOP_{t-1} \\ &+ \gamma_7 CIF_{t-1} + \gamma_8 TRB_{t-1} + \gamma_9 SUP_{t-1} + \gamma_{10} ARF_{t-1} + \gamma_{11} DIF_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

Where,

α_0 = Constant Parameter
α_{1i} -α_{5i} = Parameters for Short Run,
γ_1 - γ_5 = Multipliers for Long Run
Δ = Symbol for First Difference
k = Order for Maximum Lag
ε_t = Error Term

The Jarque – Bera statistics is given as:

$$\mathrm{JB} = \frac{N}{6}\left(S^2 + \frac{(K-3)^2}{4}\right) \quad (5)$$

Where,

JB=Jarque – Bera (Number)
S^2 = Skewness (Number)
K = Kurtosis (Number)
N = Number of Observation (Number)

3. Results and Discussion

The summary statistics of factors involved in the competitiveness of Nigerian soybean production in international trade is displayed in Table 1.

3.1. Summary statistics of predictors in determining the competitiveness of Nigeria soybean production in the international market

Table 1 displays the mean estimates of ARE, YED, WOT, SEV, SOY export, and SOY production from 2007 to 2022. The mean forecast of WOT, SOY export, and SOY production are 155,416, 923.9, 18, 940.738, and 732 187 metric tonnes, respectively. The mean estimates of ARE, YED, and SEV are 777, 374.81 ha, 946.5812 kg ha-1, and 8267310 USD, respectively. ARE has highest value of 1,207,740 ha in 2020, while the highest values of YED, WOT, SEV, SOY export, SOY production were 1295.1Kg/ha, 215, 460,396.9 tonnes,14, 251,000 USD, 34, 587.09 tones, and 1,262, 280 tones in the year 2010, 2020, 2020, 2017, and 2020 respectively (Figure 1 and Figure 2). The highest world soybean exports occurred in 2020, estimated at 173.3 million tons (Figure 3). This outcome compares with the highest soybean-producing countries, including Brazil (1st) with an estimated output of 121.2 million tons, followed by the USA (2nd) with an estimated production of 116.2 million tons, and Argentina (3rd) with an estimated output of 43.86 million tons in 2022 (FAO, 2024). The lowest values correspond to 2010 for ARE and SOY production, while those of YED, WOT, SEV, and SOY export are in 2009, 2007, 2019, and 2021 respectively. The kurtosis, skewness, and JB statistics tests were reported to determine the normality of the data. The skewness of zero and kurtosis of 3 signifies that the data are typically distributed. At the same time, the probability of the JB statistics of more than 0.05 connotes the acceptance of the null hypothesis that the data are typically distributed. All the regressors are negatively skewed, with

values close to zero and kurtosis close to 3, implying normal distribution. Moreover, the probability figures of JB were more outstanding than 0.05 for all regressors, which signifies that the variables are normally distributed.

Table 1. Summary statistics of predictors in the competitiveness of Nigerian soybean production in international market.

Predictors	ARE (Ha)	YED (100 g Ha^{-1})	WOT (tons)	S0YEV (1000 USD)	SOY Export (tons)	SOY Prod (tons)
Mean	777,374.81	9465.812	155,416,923.9	8267.31	18,940.738	732,187
Maximum	1,207,740	12,951	215, 460,396.9	14, 251	34,587.09	1,262,280
Minimum	281,890	7206	93, 716,241	46	6,184	365,080
Std Deviation	263,318.26	1309.52	40,288,692.64	11113.64	28,723.97	272,090.17
Skewness	-0.03167	-0.043865	-0.03072	-0.03164	-0.03407	-0.04528
Kurtosis	2.25738	2.326381	2.31307	2.320014	2.37009	2.47045
Jarque- Bera	**0.370354**	**0.3076778**	**0.317138101**	**0.3109749**	**0.267651**	0.264312
Sum	12,437,997	151453	2,486,670,782	132277	303051.82	11,714,992
Probability	0.0617246	0.062703	0.064432	0.069274	0.06342	0.06175
Observation	16	16	16	16	16	16

Source: Data Analysis (2024), Source: FAO (2024)
SOYEV- Soyabean Export Value, USD-United States Dollar

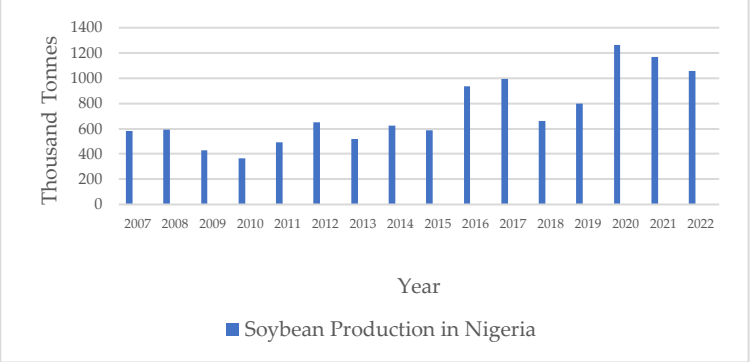

Figure 1. Soybean production (tons) in Nigeria

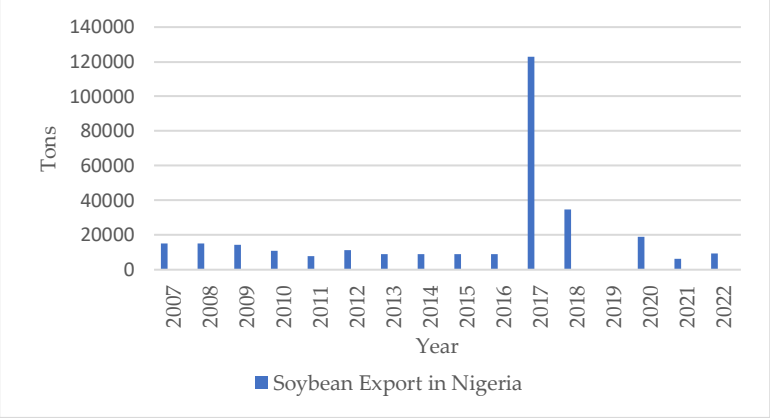

Figure 2. Soybean export (tons) in Nigeria

3.2. The ADF unit root test

The ADF Unit Root test was carried out on the stationarity data, as shown in Table 2. The outcomes display that ARE, RER, GOP, CIF, and TRB are stationary at levels I (0), while SOY, YED, WOT, SUP, ARF, and DIF are stationary at first difference I (1). The regressors have a combined order of integration. This outcome agrees

with the outcomes of Umar (2020). This set the stage for employing the Bound test for co-integration analysis and the ARDL technique.

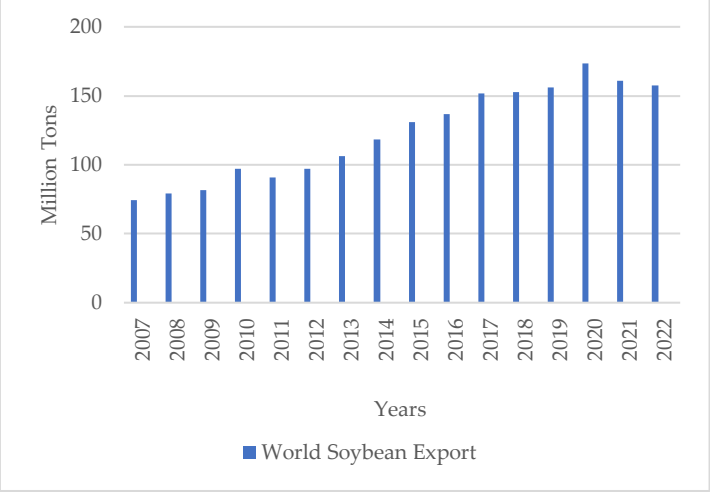

Figure 3. World soybean export in million tons.

Table 2. The ADF stationarity test.

Variables	ADF at Levels	Critical Estimates at 5%	Order of Integration	ADF at 1st Difference	Order of Integration
SOY	- 2.79	-2.96	NS	-4.18	I (1)
ARE	- 3.89	-2.96	S	Na	I (0)
YED	- 1.14	-2.96	NS	-8.09	I (1)
WOT	-1.10	-2.96	NS	-6.63	I (1)
RER	- 5.17	-2.96	S	Na	I (0)
GOP	-5.34	-2.96	S	Na	I (0)
CIF	-4.94	-2.96	S	Na	I (0)
TRB	-4.89	-2.96	S	Na	I (0)
SUP	-1.03	-2.96	NS	-6.74	I (1)
ARF	-1.07	-2.96	NS	-6.02	I (1)
DIF	-1.09	-2.96	NS	-6.79	I (1)

Source: Data Analysis (2024), NS- Not Stationary, Na-Not Available, NS-Stationary.

3.3. The co-integration test

Table 3 displays the bound test for co-integration; the outcome shows the upper and lower bounds for asymptotic or finite sample size and the actual sample size. The bound test revealed the critical estimates of 2.91 and 4.09 for the lower and upper bound, respectively, at the 5% significance level. The estimated F-statistics of 13.69 is more than the upper bound value of 4.09 at the 5% significance level. This outcome shows that the regressors in the model are co-integrated, implying a long-run association between the regressors in the model. This outcome conforms with the outcome of Olojede and Micheal (2020).

Table 3. Bounds test for co-integration result.

Significant Level	I(0) Bound	I(1) Bound	Value
10%	2.47	3.48	F-Statistics = 13.69, K = 4
5%	2.91	4.09	
1%	4.17	5.51	

Source: Data Analysis (2024).

3.4. Factors Determining the competitiveness of Nigeria's soybean in international market

Table 4 displays the regressors influencing the competitiveness of Nigeria's soybean in the international market. The ARE exerts a positive and significant influence on SOY seed export. This agrees with the a priori expectation. A unit increase in ARE cultivated for soybeans will increase SOY export by 0.79. The coefficient of YED is also positive and significant; this connotes that the output of soybean seed can translate to availability for export, which is expected to expand market access to Nigerian soybean seed. The RER has a negative coefficient, which aligns with the a priori expectation. The coefficients of GOP, TRB, SUP, and DIF had negative values and were significantly different from zero in affecting the competitiveness of soybean in international trade. This work is in line with a priori expectations. The coefficients of CIF and ARF had positive values and were significantly different from zero in affecting the competitiveness of soybeans in international trade. This outcome is in line with apriorism expectations. The infrastructure challenges are access roads to farms (ARF) and the distance of farms to nearby market infrastructures (DIF). The error correction parameter conforms to a priori expectation and is statistically significant. The extent of the co-integration term connotes that if there is any departure, the long-run equilibrium is regulated moderately, with about 86% of the disequilibrium being removed in each period. This displays the speed of regulation to where soybeans will balance even when there is disequilibrium at the rate of 86%. The explanatory power of the regressors used in explaining the competitiveness of Nigeria's soybean in international trade is shown by the summary statistics; the R^2 is 0.78 (78%). The F-statistics reveal that the model is statistically significant ($P < 0.05$). The DW calculated is 1.6 which connotes low level of autocorrelation. This outcome is in agreement with the outcomes of Alabi et al. (2022), Obansa et al. (2013), and Umar (2020).

The Estimated Long Run Equation is stated thus:

$$\underset{}{SOY} = \underset{(0.0081)}{0.79ARE} + \underset{(4.17)}{39.51YED} + \underset{(0.007)}{0.006WOT} + \underset{(4.38)}{2.13\,RER} - \underset{(0.026)}{0.162GOP} + \underset{(0.016)}{0.161CIF} - \underset{(0.024)}{0.072TRB} - \underset{(0.022)}{0.111SUP} + \underset{(0.005)}{0.021\,ARF} - \underset{(0.017)}{0.121DI} \quad (6)$$

Table 4. Estimated long run result.

Variable	Coefficient	Standard Error	t- Value
ARE	0.79***	0.081	9.75
YED	39.51***	4.17	9.47
WOT	0.006	0.007	0.86
RER	-2.14	4.38	-0.49
GOP	-0.162***	0.026	-6.23
CIF	0.161***	0.016	10.06
TRB	-0.072**	0.024	-2.99
SUP	-0.111***	0.022	-4.96
ARF	0.021***	0.005	4.07
DIF	-0.121***	0.017	-6.77
C	2.391	561.5	0.004
CointEq (-1)	-0.86***	0.086	-10.00
R^2 = 0.78			
DW = 1.6			
F =74.9**			

Source: Data Analysis (2024), DW-Durbin Watson Statistics
- Significant at 5% Probability Level, *- Significant at 1% of Probability Level

3.5. Diagnostic tests

The outcome of the diagnostic test is presented in Table 5. The outcomes connote that the model passed the test of homoscedasticity, serial correlation, normality (JB), and linearity, given that their probability values are more than 0.05; this connotes the acceptance of the null hypothesis of no serial correlation and presence of homoscedasticity, normal distribution, and no misspecification of function. This, therefore, implies that the

stochastic error term is white noise and has a mean of zero and variance that is constant. This makes the estimates reliable and consistent.

Table 5. Summary of diagnostics test.

Test	F-Statistics	Prob (F-Statistics)
No Serial Correlation (Breusch-Godfrey LM Test)	0.9102	0.4001
Homoscedasticity (Breusch-Godfrey)	5.7202	0.7104
Normality (Jarque-Bera)	2.9102	0.2104
Model Specification (Ramsey RESET)	0.6104	0.4143

Source: Data Analysis (2024)

4. Conclusions

This study was executed to determine the socio-economic and infrastructural challenges affecting the competitiveness of Nigeria's soybean production in international trade: auto-regressive distributive lag approach. The primary and secondary data were used for this research. The primary data covered the period 2007 to 2022. The ADF conducted for unit root test revealed that ARE, RER, GOP, CIF, and TRB are stationary at I (0) (level), while SOY, YED, WOT, SUP, ARF, and DIF are stationary at I (1) (first difference). The bound test showed the critical estimates of 2.91 and 4.09 for the lower and upper bound, respectively, at the 5% significance level. The estimated F- statistics of 13.69 is more than the upper bound estimate of 4.09 at the 5% significance level. The estimated long-run outcome using ARDL show that is, YED, GOP, CIF, TRB, SUP, ARF, and DIF is the significant regressors affecting the competitiveness of soybean production in the international market. The speed of regulation to where soybeans will balance even when there is disequilibrium is at the rate of 86%. The explanatory power of the regressors used in explaining the competitiveness of Nigeria's soybean in international trade is shown by the summary statistics; the R^2 is 0.78 (78%). The F-statistic reveals that the model is statistically significant ($P < 0.05$). The DW calculated is 1.6, which connotes a low level of autocorrelation. The aftermath of the diagnostic test connotes the acceptance of the null hypothesis of no serial correlation, presence of homoscedasticity, normal distribution, and no misspecification of function. Based on the outcomes of this research, the following suggestions were made:

(i) Government and private sectors must develop strategies to promote greater access to farm advisory services.

(ii) The government must invest in infrastructures such as roads, markets, and storage investment infrastructures.

(iii) Government and private organizations need to invest in the education of farmers, technical innovations, and information transfer to improve the competitiveness of the producers.

(iv) Policies should be implemented to stimulate the exportation of soybeans. Such policies include the granting of tax holidays, trade barriers, provision of storage facilities, and long-term export credit at concessionary interest rates to exporters of soybeans.

(v) Increasing the productive capacities of producers of soybeans by providing improved seeds, fertilizers, and extension services and providing credit facilities at low interest rates without administrative bottlenecks to producers.

(vi) Research activities should be carried out to improve the quality of soybeans and ensure they are free from pesticides, mycotoxins, contaminations, and aflatoxins.

(vii) The government should be in tune with favorable policies that affect the international market, such as exchange rates, training on soybean production, and capacity building on proper packaging.

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