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An Econometric Analysis of Cocoa Production in Nigeria (1970-2018)

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Abstract
The study analyzed cocoa production with the aim of identifying factors influencing outputs from 1970 - 2018. Time series data were used for the research and the analyses of the data was done using unit root tests with the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test procedure testing approach for cointegration. Determination of stationarity using ADF and PP models showed the presence of unit root and the series were integrated of order one. Analysis of cointegration test showed a long run equilibrium relationship between production and producer price, real GDP per capital, cocoa export and area harvested. Analysis of the OLS regression model revealed a positive and significant statistical relationship between annual cocoa production and producer price at 1% level, cocoa export at 5% level, and area harvested at 5% level while GDP had a negative and significant relationship at 5% level. This was explained that while an increase in producer price positively influence volume of export and area harvested of cocoa, increased in GDP led to a reduction in cocoa production. It was concluded that a sustained increase in cocoa producer prices, export and area harvested of cocoa will lead to increased cocoa output. As such, the government, NGOs and farmers should adopt policies that will improve cocoa production. This can be done by adopting a favourable export policy. Farmers' organizations and NGOs could train farmers on efficient farm management approaches.

Keywords: Cocoa, producer price, Johansen cointegration, regression,

INTRODUCTION
Agriculture plays a dominant role in the development of third world countries given its role in the provision of food, raw materials employment and foreign exchange earnings. According to Nkamleu (2010), in the course of the last 40 years in developing countries, tree crops especially cocoa, coffee, oil palm and rubber dominated the agricultural export sector. Within the tree crop sector, the cocoa tree crop enterprise stands out among the perennial crops since it supports not only the chocolate enterprise, but also the economies of producing countries. This is true of Nigeria where in the 1960s, cocoa production was an important activity, given that the country was the second largest cocoa producer. According to Samuel (2017), cocoa was ranked as the first Nigerian foreign exchange earner. This had

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since changed with reduced interest in agriculture and cocoa production. Awe (2013) attributed the reduction in cocoa production to policy shift with the discovery of oil as a major foreign exchange earner. Akinwumi (2013) posits that the oil boom led to negligence of non-oil products and a reduction in economic returns from the agricultural sector. The oil boom of the 1970s and the over-valuation of the Naira vis-à-vis other foreign currencies resulted to the "Dutch disease." This resulted to the neglect of the agricultural economy with increasing focus on oil as the major foreign exchange earner. The International Cocoa Organization (ICO) (2010) reported that Africa's production of cocoa in general declined from 71.8% in 2007 to 68% in 2010. However, Nigeria is still an important exporter of cocoa as it is the fifth largest cocoa producer worldwide with 4.6% of production and the fourth producer in Africa. Despite being a major producer of cocoa in the world, experts believe that Nigeria is still not producing to its full potential. Gbetnkom and Khan (2002) observed that there are two schools of thought explaining the decline in agricultural exports for cocoa producing countries. While one stresses factors that are external to the individual country, the other emphasizes factors that are internal to countries like the domestic policies that affected export supply.

The African agricultural sector is rainfed especially given the scarcity of irrigation facilities. The dependence on the rains to signal the beginning and end of the farming seasons shows that the continent is vulnerable to climate variation given underlying factors like poverty and low technical input. Oyakake *et al*. (2009) in their study observed that cocoa is sensitive to climate changes especially in areas with shallow soil formation. This view was similar to that of Ajewole and Iyanda (2010) who postulates that yearly variation in cocoa yield was affected more by rainfall than any other climatic factor. The effect of climate variation is eminent in matured cocoa plantations due to a decrease in soil fertility. According to Samuel (2017), cocoa performance depends amongst others on soil texture, soil structure and soil nutrient availability. Most cocoa farmers are peasants with small farm size holdings. These farmers depend on virgin forest soil fertility. Ogunlade *et al*. (2009) observed that about 70% of Nigeria cocoa farmers do not use fertilizer or carry out any agroforestry soil improvement practice to replace soil nutrients apart from natural inputs.

Another factor that influences the Nigerian cocoa sector had been the postharvest handling and marketing of the crop. Before the introduction of the Structural Adjustment Program (SAP), Nigerian cocoa was marketed through a monopoly-monopsony marketing board (commodity boards). Idowu *et al*. (2007) posits that the marketing boards were created to mediate on cocoa produce price with other objectives to; stabilize produce price, facilitate access to exchange earnings and improve on the market structure. However, the commodity boards served as a great disincentive to cocoa farmers both in production and replanting. Cadoni (2013) assert that the commodity boards represented agencies for taxation given that producer prices paid to the farmers were far below world prices. With these challenges, the 1970s and 1980s according to Idowu (1986) witnessed a consistent decline in aggregate cocoa output. After the abolition of the Marketing Boards structure however, cocoa production continues to decline. Possible reasons for the decline may be the nature of investment in cocoa production. According to Nkang *et al*. (2009), the decline may be explained in that returns from cocoa are threatened by rising costs of production, price instability, decrease in efficient management systems and declining productivity due to ageing trees. In general terms, if investment in cocoa production were attractive, farmers/investors would allocate scarce resources to cocoa farming. Given these challenges, the government abandoned SAP (though other aspects related to increase cocoa prices were still maintained). The scraping of the cocoa marketing board and SAP encouraged illegal commercial activities which lowered the quality of the Nigerian cocoa. This reduced the performance of the cocoa enterprise (Alimi and Awoyomi, 2001).

Various approaches had also been adopted to improve cocoa production. One of such method had been to increase the area under cocoa crops. Crop production generally depends on the crop area and crop yield. So, to increase production one has to raise either of them. In Nigeria, opinions differ in regard to different sizes of farm holdings by cocoa farmers. Ciba (1993) posits that cocoa cultivation in Nigeria had largely been in the hands of peasant farmers with average farm size of about 1.6 ha. Another factor that influenced cocoa production was market liberation that led to the dissolution of marketing boards in the 1980s. The dissolution of the boards contributed greatly to the removal of indirect tax imposed on agricultural export by their activities. As such, farmers benefitted from enhanced world prices for their produce. Nwachuku *et al*. (2010) pointed out that farmers from the eastern states of Nigeria responded to these price incentives by cultivating more land for cocoa plantations. On the other hand, farmers from the south-western part of the country responded through enhanced plantation management leading to increased yield. Lobell *et al*. (2009) posit that there is a greater chance to expand the land area towards crop growth due to genial environment. However, researchers recommend land improvement activity that reduces excessive land use as a way of protecting the environment without a reduction in yield (Medugu, 2006; Kanianska, 2016, Parikh, 2012; Olokesusi, 1997).

In other cocoa producing areas of Nigeria, Adeniyi and Ogunsola (2014), Oladejo (2019) and Alamu (2013) identified socio-economic characteristics of cocoa producers, marketing activities, profitability, production efficiency and botanical factors as factors influencing cocoa production. However, these studies did not use the cointegration model to verify the relationship between cocoa production variables and production. This article attempts to investigate the influence of time series variables (cocoa price, farm size, cocoa export, real GDP per capita) on the Nigerian cocoa production sector. Specifically, the study establishes the trend in cocoa production and investigates the causal factors of variation in cocoa prices, GDP per capital, volume of cocoa export and land area under cocoa crops. The study bridges the knowledge gap by assessing the factors responsible for cocoa production trends and their significance over the study areas and periods. Research on this issue is therefore important to help inform policy decisions regarding resource allocation in cocoa production.

METHODOLOGY

The study was conducted in Nigeria where annual data of the variables for cocoa production were collected covering a period 1970 - 2018. According to Oyinbo and Rekwot (2014), Nigeria lies between 4^0N and 14^0N, and between 3^0E and 15^0E. With a total area of 923,800 km^2, Nigeria occupies about 14% of land area in West Africa. The country is located within the tropics with a mean average temperature of 27^0C. The average maximum temperatures vary from 32^0C along the coast to 41^0C in the northern part of the country. The mean minimum temperature ranges from 21^0C in the coastal areas to 13^0C in the northern parts of the country. The rainfall pattern of the country varies from a wet coastal area with annual rainfall of 3,500 mm to 600 mm in the northern parts of the country. Data for the study were obtained from two sources. This include data from the website of Food and Agricultural Organization of the United Nations (FAOSTATS, 2018) and data from the political economy of cocoa exports in Nigeria (Taiwo, 2016). The econometric software EVIEWS 9 and SPSS 16 were used for the empirical analysis of the data.

Both descriptive and inferential statistical technique were used to achieve the objectives of this study. Descriptive statistics made used of mean, standard deviation, kurtosis and skewness. For inferential statistics both the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests were utilized. The ADF and PP tests statistics were used to ascertain the time series properties of the variables to avoid spurious regression which results from the regression of non-stationary time series data. The ADF and the PP models were analyzed with the constant term and the null hypothesis (H_0: β=0) of the ADF and PP tests shows that the data series is not stationary while the alternative hypothesis (H_I: β<0) shows that the data series is stationary (Oyinbo and Rekwot, 2014). In an attempt to determine how the variable inputs affect cocoa production, the Johansen cointegration tests and the ordinary least square technique were applied on the data.

Model specification

The ordinary least square regression model was used for analysis of the data. The total volume of cocoa produced was explained by the annual price of cocoa (₦), area harvested (ha), index of real GDP per capita (₦) and cocoa export (tons). It was assumed that cocoa production follows the multiple regression model presented in the implicit form following the works of Darkwah and Verter (2014) in (i) as:

$$lnPRO = f\,(lnPRI, lnARE, lnGDP, lnEXP) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(i)$$

Equation (i) can be simplified and expressed in the explicit form in (ii) as;

$$lnPRO = \beta_0 + \beta_1 lnPRI + \beta_2 lnARE + \beta_3 lnGDP + \beta_4 lnEXP + \varepsilon_i \ldots\ldots\ldots\ldots\ldots.\ldots..\ldots...(ii)$$

Where:

PRO = production quantity of cocoa (tons), PRI = producer price of cocoa (₦), ARE = Cocoa area harvested (ha), GDP = the real gross domestic product (₦), EXP = volume of cocoa export (tons), β_1 = coefficient to be estimated, ln = natural log ε_i = error tern and β_0 = constant term.

RESULTS AND DISCUSSION

Table 1 gives a summary statistic for variables that are hypnotized to affect cocoa production in Nigeria. The mean value of 280283.3 tons of cocoa were produced in a period of 48 years.

Table 1: Summary statistics for dependent and explanatory variables from (1970-2018)

	PRODUCTION	PRICE (₦)	GDP	EXPORT	AREA
Mean	280283.3	140909.5	22138994	185446.8	883943.6
Median	298029	61180	2434513	189985	739000
Maximum	485000	663453.5	1.29E+08	294661	1359550
Minimum	140000	288	24303.07	92891	700000
Std. Dev.	91221.21	188754.4	35679127	48667.61	231430.4
Skewness	0.048636	1.254106	1.615659	0.230128	0.810773
Kurtosis	1.985139	3.326749	4.363385	2.469128	2.078058
Jarque-Bera	2.122119	13.06236	24.60046	1.007891	7.103749
Probability	0.346089	0.001457	0.000005	0.604142	0.028671
Sum	13733883	6904565	1.06E+09	9086892	43313238

Source: Author's computation, 2020

Skewness measures the degree of asymmetry or deviation of the variables from a normal distribution with an expected value of zero. The results for skewness showed that production and export had values of 0.04 and 0.23 respectively which were closer to zero showed normal distribution. Kurtosis measures the degree of flatness or peakness of a series. The values of kurtosis for cocoa production was 1.98, export was 2.46 and area under cocoa production was 2.07. These values were lower than 3 meaning that the variables were platykurtic with most of their values below their sample mean. Price and GDP were skewed to the right. They show positive skewness and are leptokurtic because their values were above 3. The Jarque-Bera statistic measures the difference of the skewness and kurtosis of the series with those from a normal distribution. For this study, the P-value for Jarque-Bera statistics for production and export were greater than 5% statistical level of significance. Thus, the null hypothesis that these variables were normally distributed is accepted. The P-values for cocoa price, GDP and export were statistically lower than 5% level of significance, meaning that the null hypothesis of normal distribution was rejected. Oyinbo and Rekwot (2014) in their study on agricultural production and economic growth in Nigeria had similar results.

Unit Root Test

Table 2 shows the results estimated using the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) Unit Root Tests. This was used to determine stationarity or nonstationary. A stationary series will not vary with the specified sampling period. After comparing the results of the ADF and PP statistics with the critical values at 5% level, it was observed that there was unit root at level. This imply that the null hypothesis of non-stationarity was accepted. However, all the variables become stationary in their first differences showing the presence of unit root. The results show that the data cannot be used for prediction due to the effect of spurious regressions (Wasiu and Ndukwe, 2018). Therefore, there was the need to carry out a cointegration test to establish a long run relationship for the series. The Johansen cointegration and ordinary least squares models were employed following the works of Dabin and Tomek (2004).

Table 2: Augmented Dickey Fuller Test and Phillips-Perron (with constant term only)

Variable		ADF Statistics	Critical Values		Inference	PP Statistic	Critical Values		Inference
			1%	5%			1%	5%	
LnPRO	First dif	-3.324**	-3.589	-2.929	1(1)	-9.822***	-3.578	-2.925	1(1)
	Level	-1.589	3.592	-2.931	1(0)	-1.870	-3.574	-2.924	1(0)
LnPRI	First dif	-5.845***	-3.578	-2.925	1(1)	-5.773***	-3.577	-2.925	1(1)
	Level	-0.932	-3.574	-2.924	1(0)	-0.940	-3.574	-2.924	1(0)
LnARE	First dif	-9.366***	-3.577	-2.925	1(1)	-9.705***	-3.578	-2.925	1(1)
	Level	-0.405	-3.578	-2.925	1(0)	-0.310	-3.574	-2.924	1(0)
LnGDP	First dif	-6.907***	-3.578	-2.925	1(1)	-6.991***	-3.578	-2.925	1(1)
	Level	-0.663	-3.574	-2.924	1(0)	-0.399	-3.574	-2.924	1(0)
lnEXPO	First dif	-5.216***	-3.589	-2.930	1(1)	-14.184***	-3.577	-2.925	1(1)
	Level	-0.551	-3.589	-2.929	1(0)	-3.812**	-3.574	-2.992	1(0)

Note: The asterisks (**, ***) denote statistical significance at 0.05, and 0.01 levels respectively. ADF = Augmented Dickey- Fuller test, and PP = Phillips-Perron (PP) test. df = difference

Source: Author analysis, 2020

Vector Autoregression (VAR) Lag Order Selection Criteria

The VAR model was fitted to the data to estimate an appropriate lag structure for the granger causality test. The results for the optimal lag length for the variables in the system are presented on Table 3. This was necessitated by the sensitivity of granger causality to lag length structure (Oyinbo and Emmanuel, 2012). The results for sequential modified LR test statistic (each test at 5% level), Final Prediction Error (FPE) and Akaike Information Criterion (AIC) indicated lag order selected by the criterion 2. Thus, lag level 2 was used to test for cointegration.

Table 3: Lag order selection criteria;

PRODUCTION, PRICE, GDP, EXPORT, AREA

Lag	LogL	LR	FPE	AIC	SC	HQ
0	114.7294	NA	5.24e-09	-4.876864	-4.676124	-4.802030
1	297.5797	316.9404	4.75e-12	-11.89243	-10.6879*	-11.443*
2	324.4231	40.56334*	4.56e-12*	-11.9743*	-9.766215	-11.15118
3	339.7561	19.76262	7.84e-12	-11.54472	-8.332872	-10.34737
4	370.8902	33.20968	7.51e-12	-11.81734	-7.601797	-10.24583

* indicates lag order selected by the criterion (2)
LR: sequential modified LR test statistic (each test at 5% level) SC: Schwarz information criterion
FPE: Final prediction error AIC: Akaike information criterion;
FPE: Final prediction HQ: Hannan-Quinn information criterion error;

Johansen test for cointegration

Having observed that the variables were stationary at first difference, a cointegration test was performed using the Johansen cointegration procedure. The reason was to establish the presence of a long-run relationship between factors affecting cocoa production in Nigeria.

Table 4: Maximal eigenvalue and trace test results for cointegration (constant)

Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	Max-Eigen Statistic	5% Critical Value	Decision
None *	90.96447	69.81889	46.29039	33.87687	**Reject**
At most 1	44.67408	47.85613	18.33626	27.58434	**Accept**
At most 2	26.33782	29.79707	14.38999	21.13162	**Accept**
At most 3	11.94783	15.49471	10.17946	14.26460	**Accept**
At most 4	1.768369	3.841466	1.768369	3.841466	**Accept**

* denotes rejection of the hypothesis at the 0.05 level

A relationship is assumed to exist even if the series is drifting apart or trending either upward or downward. The model was estimated by stating the null hypothesis that there were no cointegrating equations (H_0: r = 0) against the alternative hypothesis that there were one or more cointegrating equations (H_i:r > 0). Table 4 shows the cointegration test results of Trace statistics and Maximal-Eigen statistics at level. When the value for Trace statistics and Max-Eigen statistics were more than critical values at 5% level, the null hypothesis of no cointegrating equation was rejected. The alternative hypothesis, that there was a long run equilibrium relationship between the variables was accepted as the variables were likely to be moving together in the long run. Shocks in the short run may affect movement in the individual series, but the series will converge with time in the long run. The presence of cointegration variables also imply that the series are related and can combine in a linear fashion. As a result, it was assumed that some of the variables in the model were the determinants of cocoa production in Nigeria. These factors were determined using the OLS regression analysis model following the works of Darkwah and Verter (2014).

Diagnostic tests result for the OLS model

Before conducting the OLS to test if there was any significant relationship between annual cocoa production and the independent variables, there was need to first carry out a diagnostic test. Table 5 shows the results of diagnostic model test results for OLS regression model. The estimated model diagnostic values were all greater than 5% and satisfy the *a priori* econometric test results. For example, the model showed that the variables had minimum variance, and the null hypothesis of no heteroskedasticity was accepted (given the P-value was 17.9% for Breusch-Pagan and 24.6% for white). The diagnostic test for normality revealed normally distributed variables; this was confirmed given that the P-values for Jarque-Bera was greater than 5%. Results for Breusch-Godfrey LM test, the Ramsey-Reset models showed the t-statistics, f-statistics and the likelihood ratios were all greater than 5% level.

Table 5. Diagnostic tests for OLS model

Item	Test type	P-value
	t-statistics	0.0763
Ramsey's Reset	F-statistics	0.0763
	Likelihood ratio	0.0567
Heteroskedasticity	Breusch-Pagan	0.1799
	White	0.2468
Normality	Jarque-Bera	0.9764
Serial correlation	Breusch Godfrey LM test	0.0503

Author analysis, 2020

The test for stability of the series was estimated as shown in Table 5 using the Cusum test.

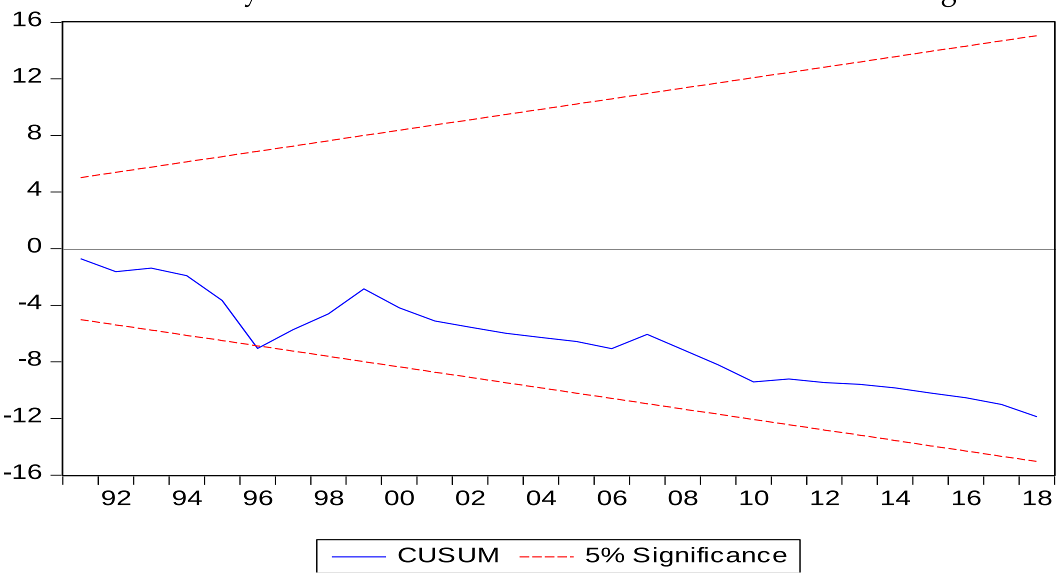

Figure 2: Stability estimation of dependent variable using Cusum test

The results showed that the dependent variable falls within the 5% boundary signifying the stability of the variables. This is an indication that the dependent variable can be estimated. Since the model satisfied the classical assumptions of the linear regression model, the data was used to estimate the effect of the independent variables on cocoa production.

The Ordinary Least Square Linear Regression

Table 6 shows the estimated OLS models for cocoa production from 1970-2018 in Nigeria. The result suggests a good fit given R^2 value of 0.7064. This shows that 70.64% variations in cocoa production in Nigeria could be explained by the estimated independent variables. F-test with a value of 25.87 and statistically significant at 1% level suggests that cocoa production inputs were indispensable when considering the importance of cocoa to the economy. The value for F-statistics revealed a goodness of fit of the model and a joint influence of the variables in cocoa production. The standard error (SE) of regression was 0.1998, explaining that deviation occurred from predicting the slope coefficient correctly of the regression model. The result was similar to that of Adefemi (2019) who used a cross-sectional data to estimate the profitability and efficiency of cocoa marketing.

Table 6: Regression model (OLS) from (1970-2018)

Variable	Coefficient	Standard Error	t-Statistic	Probability
C	-0.2445	3.5649	-0.0685	0.9456
lnPRICE	0.2487***	0.0726	3.4220	0.0014
LnGDP	-0.1939**	0.0800	-2.4223	0.0197
lnEXPORT	0.3249**	0.1339	2.4253	0.0196
Ln AREA	0.6686**	0.3163	2.1134	0.0404
		Diagnostic Parameters		
R-squared		0.7064		
Adjusted R-squared		0.6791		
S.E. of regression		0.1998		
F-statistic		25.8669		
Prob(F-statistic)		0.0000		

Note: ** and ***) denote statistical significance at 5%, and 1% levels respectively

The coefficient for price (lnPRICE) was positive and statistically significant at 1% level showing a positive influence on cocoa production. This implies that for every unit increase in producer price of cocoa, the total annual cocoa output will increase by 0.248 units *ceteris paribus*. This shows the importance of price in relation to improved management of agricultural farms. Hütz-Adams (2018) in his study had similar results and observed that changes in cocoa producer price may be due to variation in global output, consumption and speculative activity of marketers. The real gross domestic product per capita (lnGDP) indicated a negative relationship with cocoa production and was statistically significant at 5% level. This showed that a 1% increase in GDP will lead to a 19.3% decrease in cocoa production. The result does not follow *a priori* expectation that increase in GDP might lead to more consumption of cocoa products.

The coefficient for cocoa export (lnEXPORT) was positive and statistically significant at 5% level. This means that a unit increase in the volume of cocoa export will increase total annual cocoa production by 32.4 units. This may be explained in terms of increased access to cocoa production inputs as a result of foreign exchange earnings that accrue to farmers with increase in cocoa export. Verter (2016) had similar results and opined that countries with comparative advantage in cocoa production should concentrate more on production and export. The area under cocoa (lnAREA) was positive and statistically significant at 5% level. This suggests that a unit increase in area under cocoa farms will lead to an increased in total cocoa production by 66.8 units. Falola and Fakayode (2014) had similar results and opined that volume of cocoa produced was direct related to the area under cocoa crops.

CONCLUSION AND RECOMMENDATIONS

The objective of the research was to determine the relationship between annual cocoa production and variables that may influence cocoa production in Nigeria. The study made use of time series data on the index of production quantity of cocoa, producer price, cocoa area harvested, real gross domestic product and volume of cocoa exported. The Augmented Dickey Fuller (ADF), Phillips-Perron (PP) tests and the ordinary least square regression model were used to analyze the data leading to the major findings of the study. It was established that cocoa producer price was positive and statistically significant, implying that output of cocoa will continue to increase as long as the producers have a good price for their produce. In contrast, the GDP was significant, but negatively related to cocoa production. This may show that the trend in GDP growth in Nigeria had not yielded a tangible improvement in the wellbeing of the cocoa producers. Export was positive and significantly affects cocoa production in the country. This shows that cocoa production will significantly improve with an improvement in export. Similarly, area under cocoa was positive and significantly related to production. This is an indication of an improvement in cocoa production with a sustained increase in area harvested by cocoa farmers. Therefore, government, NGOs and the farmers should adopt practices that will lead to a sustained price increase for cocoa producers. This could be achieved by the government adopting favourable export policy that will bring in more foreign exchange earnings. Also, an improvement in cocoa value chain will yield more revenue and improve on the GDP of the country. Farmers' organizations could help to train the farmers in cocoa management. An efficient cocoa farm management will influence area under cocoa and increase in cocoa production.

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