Cocoa Production as a Viable Solution to Nigerian "Dutch Disease"

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Abstract

The present research determined the ex-post and ex-ante performance of cocoa beans production in Nigeria using dated data for 56 years (1961-2017) collected from FAO database. Both descriptive and inferential statistics were used to analyze the collected data. The empirical evidence showed that the nation has not maximized its potential in cocoa beans production since independent to date as the annual productivity, which was the major driving force of production increased marginally year-in-year-out. In addition, there was little or no change in the annual area throughout most of the studied periods i.e. stagnation in area contributed to slowing down the production trend of cocoa beans production in the country. The fluctuation in the annual production growth of the cocoa beans production was caused by technological, institutional and marketing risks. The forecasted production trend is disheartening, as the nation will lose a reasonable amount of foreign exchange owing to low productivity. Therefore, the study calls for urgent intervention by the policymakers on production and development investments especially climate-smart agriculture so as to attain desirable high productivity as the crop stands a better chance to shore-up the revenue deficit affecting the nation's economy.

Keywords: Growth, Forecast, Instability, Cocoa beans, Nigeria

Nijerya'da "Hollanda Hastalığı"na Çözüm Olarak Kakao Üretimi

Öz

Bu araştırma, FAO veritabanından toplanan 56 yıllık verileri (1961-2017) kullanarak Nijerya'da kakao çekirdeği üretiminin ex-post ve ex-ante performansını belirlemiştir. Toplanan verileri analiz etmek için hem tanımlayıcı hem de çıkarımsal istatistikler kullanılmıştır. Ampirik kanıtlar, üretimin ana itici gücü olan yıllık verimlilik yıllık bazda arttıkça, ülkenin bugüne kadar bağımsız olarak kakao çekirdeği üretimindeki potansiyelini en üst düzeye çıkarmadığını gösterdi. Ayrıca, incelenen dönemlerin çoğu boyunca yıllık alanda çok az değişiklik olmuştur veya hiç değişmemiştir, yani bölgedeki durgunluk, ülkedeki kakao çekirdeği üretiminin üretim trendinin yavaşlamasına katkıda bulunmuştur. Kakao çekirdekleri üretiminin yıllık üretim artışındaki dalgalanma, teknolojik, kurumsal ve pazarlama risklerinden kaynaklanmıştır. Ülke, düşük verimlilik nedeniyle makul miktarda döviz kaybedeceğinden, öngörülen üretim eğilimi cesaret kırıcı. Bu nedenle, çalışma, ülke ekonomisini etkileyen gelir açığını artırmak için daha yüksek bir şansa sahip olduğundan, arzu edilen yüksek verimlilik elde etmek için politika yapıcılar tarafından özellikle iklim akıllı tarım olmak üzere üretim ve geliştirme yatırımlarına acil müdahale çağrısında bulunmaktadır.

Anahtar Kelimeler: Büyüme, Tahmin, Kararsızlık, Kakao çekirdekleri, Nijerya

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1. Introduction

Before the "Dutch disease" expressed as the neglect of agricultural economy while focusing on crude oil, Nigeria was the second-largest producer of cocoa in the world; it plummeted to the fourth position in the year 2006/2007 (Erelu, 2008) and now the sixth position. In the 1950s and 60s, cocoa was a major agricultural export commodity and a top source of foreign exchange earnings, thus decades of glory for cocoa. Because of the mono-economy nature of the country i.e. heavy reliance on oil proceeds, the country fell victim of an economic recession that owed to the oil price crash in 2015/2016. Therefore, the need for revenue diversification became more apparent as the recession deepened. With the current rebound in global oil prices, the increase in the pace of oil production and gross domestic product (GDP) growth creeping back into positive territory, the push for diversification may once again take a back seat. It is important, however, to recognize that the rate of economic growth can be accelerated if revenue-earning agricultural commodities are given adequate attention. The urgent need for diversification of the economy requires unwavering action. An investment in the cocoa industry should be part of this strategy as Nigeria was once a powerhouse in cocoa production and has the agricultural land and climate to sustain it.

Approximately 80% of cocoa produced in Nigeria is exported as cocoa beans while the 20% is processed into powder, butter, cake and liquor before being exported. Yet the country has not fully capitalized on cocoa production, as most of the beans are sold unprocessed. In both the local and international markets, cocoa remains one of the marketable and most desirable agricultural commodities as its demand is very robust, moving in tandem with the rapid growth and expansion of chocolate confectioneries and other related products. Despite the challenges in 2016, the long-term prospects remain largely promising due to growing global demand, particularly in Asia. Demand for cocoa powder and chocolate in the world's second-largest economy will likely increase by 5% and 4% respectively in 2017/2018.Farmers are responding to rising international market prices for cocoa and reports indicated a potential increase in production resulting from the adoption of improved production practices to meet the UTZ certification requirements. There are indications that farmers are willing to rehabilitate abandoned farms and to increase the area under production (GAIN, 2014). While the crop is sometimes cultivated on a large-scale in Nigeria, the small-scale farmers dominated the sector, thus, it remains a critical source of livelihood for rural populations in states where the crop is produced. It is in view of the above that this research aimed at examining the *ex-post* and *ex-ante* performance of cocoa beans production in Nigeria. The specific objectives were i) to examine the trend and growth pattern of cocoa production; ii) to determine the magnitude and sources of instability in cocoa beans production; iii) to determine the source of growth in the cocoa beans production; iv) to determine the factors influencing farmers' acreage allocation decision; and, v) to forecast the production trend of cocoa beans production in the studied area.

2. Methodology

Nigeria is a country in sub-Saharan Africa and lies on latitudes 4′ to14′ N and longitudes 2′ to 15′ E of the Greenwich meridian time (CIA, 2011).The country is blessed with vast arable land for agricultural activities and it has abundant human and natural resources. The study made use of dated data, which was sourced from FAO database, and it covered a period of 56 years (1961-2017). The collected data included production, area, yield and producer price of cocoa beans. For proper examination, the data were decomposed into the three policy regime periods that marked the economy of the country *viz.* pre-Structural Adjustment Period (pre-SAP) (1961-1984), SAP (1985-1999) and post-SAP (2000-2017). The collected data were analyzed using both descriptive and inferential statistics. Objective I was achieved using descriptive statistics and growth model; Objective II was achieved using instability indexes and Hazell's decomposition model; Objective III was achieved using instantaneous change model and Hazell's decomposition model; Objective IV was achieved using Autoregressive distributed lag model; and, Objective V was achieved using ARIMA model.

Empirical model

Growth rate: The compound annual growth rate calculated using the exponential model is given below (Sadiq *et al*., 2017):

$$\gamma = \alpha\beta^t \quad (1)$$
$$ln\gamma = ln\alpha + tln\beta \quad (2)$$
$$CAGR = [Antilog\beta - 1] \times 100 \quad (3)$$

Where, CAGR is compound growth rate; t is time period in year; γ is area/yield/production; α is intercept; and, β is the estimated parameter coefficient.

Instability index: Coefficient of variation (CV), Cuddy-Della Valle Index and Coppock's index were used to measure the variability in the production, area and yield. Following Sandeep *et al*.(2016) and Boyal *et al*.(2015) the CV is shown below:

$$CV(\%) = \frac{\sigma}{\bar{X}} * 100 \quad (4)$$

Where, σ is standard deviation and $\bar{X}$ is the mean value of area, yield or production.

The simple CV overestimates the level of instability in time series data characterized by long-term trends, whereas the Cuddy-Della Valle Index corrects the coefficient of variation by instability index as it de-trend the annual production and show the exact direction of the instability (Cuddy and Valle, 1978). Thus, it is a better measure to capture the instability of agricultural production and prices, and it is given below:

$$CDII = CV*(1-R^2)^{0.5} \quad (5)$$

Where CDII is the Cuddy-Della instability index; CV is the coefficient of variation; and, R^2 is the coefficient of multiple determination. Following Shimla (2014) as adopted by Umar *et al*. (2019), the instability index was classified as low instability (≤20%), moderate instability (21-40%) and high instability (>40%).

Unlike CV, Coppock's instability index give close approximation of the average year-to-year percentage variation adjusted for trend (Ahmed and Joshi, 2013; Kumar *et al*., 2017; Umar *et al*., 2019) and the advantage is that it measures the instability in relation to the trend in prices (Kumar *et al*., 2017). According to Kumar *et al*.(2017), a higher numerical value for the index represents greater instability. Following Coppock (1962), the algebraic economic formula as used by Ahmed and Joshi (2013); Sandeep *et al*.(2016); Kumar *et al*.(2017); Umar *et al*.(2019) is given below:

$$CII = \left(Antilog\sqrt{\log V} - 1\right) * 100 \quad (6)$$

$$\log V = \frac{\sum\left[log\frac{X_{t+1}}{X_t} - m\right]^2}{N-1} \quad (7)$$

Where,

$X_t = Area\ or\ Yield\ or\ Production\ in\ year\ 't',\ N = number\ of\ year(s)$, CII= Coppock's instability index; $m = mean\ difference\ between\ the \log of\ X_{t+1} and\ X_t$; and, $logV = Logarithm\ Variance\ of\ the\ series$

Source of change in cocoa production

Instantaneous change: Following Sandeep *et al*.(2016) the instantaneous decomposition analysis model used to measure the relative contribution of area and yield to the total output change is given below:

$$P_0 = A_0 \times Y_0 \quad (5)$$
$$P_n = A_n \times Y_n \quad (6)$$

Where, P, A and Y represent the production, area and yield respectively. The subscript 0 and n represent the base and the n^{th} years respectively.

$$P_n - P_0 = \Delta P \quad (7)$$
$$A_n - A_0 = \Delta A \quad (8)$$
$$Y_n - Y_0 = \Delta Y \quad (9)$$

From equation (5) and (9) we can write;

$$P_0 + \Delta P = (A_0 + \Delta A)(Y_0 + \Delta Y) \quad (10)$$

Therefore,

$$P = \frac{Y_0 \Delta A}{\Delta P} \times 100 + \frac{A_0 \Delta Y}{\Delta P} \times 100 + \frac{\Delta A \Delta Y}{\Delta P} \times 100 \quad (11)$$

$$Production = Area\ effect + Yield\ effect + Interaction\ effect \quad (12)$$

Hazell's decomposition model: In estimating the change in average production and change in the variance of production with respect to between regimes and the overall period, Hazell's (1982) decomposition model was used. Hazell decomposed the sources of change in the average of production and change in production variance into four (4) and ten (10) components as cited by Umar *et al.*(2017 and 2019).

Decomposition analysis of change in production assesses the quantum of increase or otherwise of production in year 'n' over the base year that results from a change in the area, productivity or interaction.

i. Changes in average production: It is caused by changes in the covariance between area and yield and changes in mean area and mean yield. The model is shown below:

$$E(P) = \bar{A}\bar{Y} + COV(A,Y) \quad (13)$$

$$\Delta E(P) = E(P_2) - E(P_1) = \bar{A}_1 \Delta \bar{Y} + \bar{Y}_1 \Delta \bar{A} + \Delta \bar{A} \Delta \bar{Y} + \Delta COV(A,Y) \quad (14)$$

Table 1. Components of change in the average production

Sources of change	Symbols	Components of change
Change in mean area	$\Delta\bar{A}$	$\bar{A}_1\Delta\bar{Y}$
Change in mean yield	$\Delta\bar{Y}$	$\bar{Y}_1\Delta\bar{A}$
Interaction effect	$\Delta\bar{A}\Delta\bar{Y}$	$\Delta\bar{A}\Delta\bar{Y}$
Changes in area-yield covariance	$\Delta COV(A,Y)$	$\Delta COV(A,Y)$

ii. Change in variance decomposition: The source of instability is caused by ten factors and shown below is the model:

$$V(P) = \bar{A}^2.V(Y) + \bar{Y}^2.V(A) + 2\bar{A}\bar{Y}COV(A,Y) - COV(A,Y)^2 + R \quad (15)$$

Table 2. Components of change in variance production

Sources of change	Symbols	Components of change
Change in mean area	$\Delta\bar{A}$	$2\bar{Y}\Delta\bar{A}COV(A,Y) + \{2\bar{A}\Delta\bar{A} + (\Delta\bar{A})^2\}V(Y)$
Change in mean yield	$\Delta\bar{Y}$	$2\bar{A}\Delta\bar{Y}COV(A,Y) + \{2\bar{Y}\Delta\bar{Y} + (\Delta\bar{Y})^2\}V(A)$
Change in area variance	$\Delta V(A)$	$\bar{Y}^2V(A)$
Change in yield variance	$\Delta V(Y)$	$\bar{A}^2V(Y)$
Interaction effect I (changes in mean area and mean yield)	$\Delta\bar{A}\Delta\bar{Y}$	$2\Delta\bar{A}\Delta\bar{Y}COV(A,Y)$
Changes in area-yield covariance	$\Delta COV(A,Y)$	$\{2\bar{A}\bar{Y} - 2COV(A,Y)\}COV(A,Y) - \{\Delta COV(A,Y)\}^2$
Interaction effect II (changes in mean area and yield variance)	$\Delta\bar{A}\Delta V(Y)$	$\{2\bar{A}\Delta\bar{A} + (\Delta\bar{A})^2\}\Delta V(Y)$
Interaction effect II (changes in mean yield and area variance)	$\Delta\bar{Y}\Delta V(A)$	$\{2\bar{Y}\Delta\bar{Y} + (\Delta\bar{Y})^2\}\Delta V(A)$
Interaction effect IV (changes in mean area and mean yield and changes in area-yield	$\Delta\bar{A}\Delta\bar{Y}COV(A,Y)$	$(2\bar{A}\Delta\bar{Y} + 2\bar{Y}\Delta\bar{A} + 2\Delta\bar{A}\Delta\bar{Y})\Delta COV(A,Y)$
Residual	ΔR	$\Delta V(AY)$

Nerlovian model: Following Sadiq *et al.*(2017), the basic model which has come to be called as Nerlovian price expectation model is as follows:

$$A_t = \alpha + \beta_i P_t^* + \varepsilon_t \quad (16)$$

$$(P_t^* - P_{t-1}^*) = \beta(P_{t-1} - P_{t-1}^*) 0 < \beta < 1 \quad (17)$$

Where;

$A_t = Actual\ acreage\ under\ the\ crop\ in\ year\ 't'$

$P_t^* = Expected\ price\ of\ the\ crop\ in\ year\ 't'$

$P_{t-1}^* = Expected\ price\ of\ the\ crop\ in\ year\ 't-1'$

$P_{t-1} = Actual\ price\ of\ the\ crop\ in\ year\ 't-1'$

$\alpha = Intercept$

$\beta = Coefficient\ of\ price\ expectation$

$\varepsilon_t = Disturbance\ term$

The Nerlovian model depicting farmer's behavior in its simplest form is shown below:

$$A_t^* = \beta_0 + \beta_1 P_{t-1} + \beta_2 PR_{t-1} + \beta_3 Y_{t-1} + \beta_4 CYR_{t-1} + \beta_5 T_t + \beta_6 WI_t + \varepsilon_t \quad (18)$$

$$A_t - A_{t-1} = \beta(A_t^* - A_{t-1})(Nerlovian\ adjustment\ equation) \quad (19)$$

As expected variables are not observable, for estimation purpose, a reduced form containing only observable variables may be written after substituting the value of A_t^* from equation (19) into equation (18), and is as follow:

$$A_t^* = \beta_0 + \beta_1 P_{t-1} + \beta_2 PR_{t-1} + \beta_3 Y_{t-1} + \beta_4 YR_{t-1} + \beta_5 T_t + \beta_6 WI_t + \beta_7 A_{t-1} + \varepsilon_t \quad (20)$$

The first equation is a behavioral equation, stating that desired acreage (A_t^*)depend upon the following independent variables:

Where,
$A_t = current\ area\ under\ the\ studied\ crop$;
$P_{t-1} = one\ year\ lagged\ price\ of\ the\ studied\ crop$
$PR_{t-1} = one\ year\ lagged\ price\ risk\ of\ the\ studied\ crop$
$Y_{t-1} = one\ year\ lagged\ yield\ of\ the\ studied\ crop$
$YR_{t-1} = one\ year\ lagged\ yield\ risk\ of\ the\ studied\ crop$
$T_t = time\ trend\ at\ period\ t$;
$WI_t = one\ year\ lagged\ weather\ index$;
$A_{t-1} = one\ year\ lagged\ area\ under\ the\ studied\ crop$;
$\beta_0 = intercept$;
$\beta_{1-n} = parameter\ estimates$;
$\varepsilon_t = Disturbance\ term.$

Price and yield risks were measured by the standard deviation of the three preceding years. For the weather index, the impact of weather on yield variability was measured with a Stalling index (Stalling, 1960). The yield was regressed on time to obtain the expected yield. The actual to the predicted yield ratio is defined as the weather variable. The weather effects such as rainfall, temperature etc. may be captured by this index in the acreage response model (Ayalew, 2015).

The extent of adjustment to changes in the price and/or non-price factors is measured in terms of the "coefficient of adjustment". The adjustment takes place in accordance with the actual planted area in the preceding year. If the coefficient of adjustment is one, farmers fully adjust area under the crop in the current year itself and there will be 'no lags' in the adjustment. But if the coefficient of adjustment is less than one, the adjustment goes on and gives rise to lags, which are distributed over time. The number of years required for 95 percent of the effect of the price to materialize is given below (Sadiq *et al.* 2017):

$$(1 - r)^n = 0.05 \quad (21)$$

Where r = coefficient of adjustment (1-coefficient of lagged area), and n = number of year.

In the present study, both short-run (SRE) and long-run (LRE) elasticities of the area under the crop with respect to price were estimated to examine and compare the effect of price on the responsiveness of area in the short-run as well as in the long-run. The price elasticities are given below:

$$SRE = Price\ coefficient * \frac{Mean\ of\ price}{Mean\ of\ area} \quad (22)$$

$$LRE = \frac{SRE}{Coefficient\ of\ adjustment} \quad (23)$$

ARIMA

Box and Jenkins (1976) posited that a non-seasonal ARIMA model is denoted by ARIMA (p,d,q), which is a combination of Auto-regressive (AR) and Moving Average (MA) with an order of integration or differencing (d). The p and q are the order of autocorrelation and the moving average respectively (Gujarati *et al.*, 2012).

The Auto-regressive of order p denoted as AR(p) is given below:

$$Z_t = \alpha + \delta_1 Z_{t-1} + \delta_2 Z_{t-1} + \cdots .. + \delta_p Z_{t-p} + \varepsilon_t \quad (24)$$

Where α is the constant; δ_p is the p-th autoregressive parameter and ε_t is the error term at time 't'.

The general Moving Average of (MA) of order q or MA(q) can be written as follow:

$$Z_t = \alpha + \varepsilon_t - \varphi_1\varepsilon_{t-1} - \varphi_2\varepsilon_{t-1} - \cdots .. - \varphi_q\varepsilon_{t-q} \quad (25)$$

Where α is the constant; φ_q is the q-th moving average parameter and ε_{t-k} is the error term at time 't-k'.

ARIMA in general form is as follows:

$$\Delta^d Z_t = \alpha + \left(\delta_1\Delta^d Z_{t-1} + \cdots .. + \delta_p\Delta^d Z_{t-p}\right) - (\varphi_1\varepsilon_{t-1} + \cdots .. + \varphi_q\varepsilon_{t-q}) + \varepsilon_t \quad (26)$$

Where, Δ denotes difference operator like;

$$\Delta Z_t = Z_t - Z_{t-1} \quad (27)$$

$$\Delta^2 Z_{t-1} = \Delta Z_t - \Delta Z_{t-1} \quad (28)$$

Here, $Z_{t-1} \dots \dots \dots, Z_{t-p}$ are values of past series with lag 1,………., p respectively.

Modeling using ARMA methodology consists of four steps viz. model identification, model estimation, diagnostic checking and forecasting.

Forecasting Accuracy

For measuring the accuracy in fitted time series model, mean absolute prediction error (MAPE), relative mean square prediction error (RMSPE), relative mean absolute prediction error (RMAPE) (Paul, 2014), Theil's U statistic and R^2 were computed using the following formulae:

$$MAPE = 1/T\sum_{i=1}^{5}(A_{t-1} - F_{t-1}) \quad (29)$$

$$RMPSE = 1/T\sum_{i=1}^{5}(A_{t-1} - F_{t-1})^2/A_{t-1} \quad (30)$$

$$RMAPE = 1/T\sum_{i=1}^{5}(A_{t-1} - F_{t-1})/A_{t-1} \times 100 \quad (31)$$

$$U = \sqrt{\frac{\sum_{t=1}^{n-1}\frac{(\hat{Y}_{t+1} - Y_{t+1})^2}{Y_t}}{\sum_{t=1}^{n-1}\frac{(Y_{t+1} - Y_t)^2}{Y_t}}} \quad (32)$$

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(A_{ti} - F_{ti})}{\sum_{i=1}^{n}(A_{ti})} \quad (33)$$

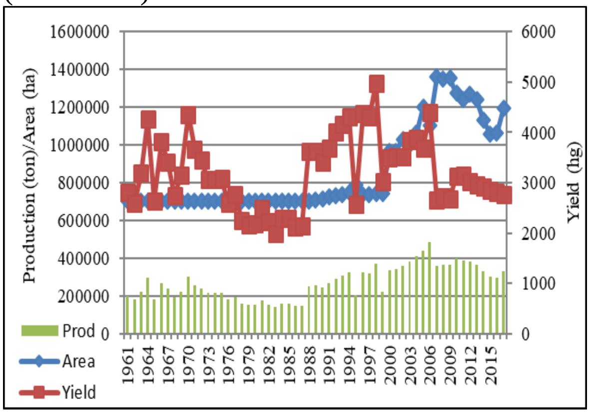
Where, R^2= coefficient of multiple determination, A_t = Actual value; F_t = Future value, and T = time period.

3. Results and Discussion

3.1. Trend and growth pattern of cocoa beans production

The graph showed a cyclical production trend *viz.* two phases with the first and second cycles been low and moderate, respectively (Figure 1).

Figure 1. Production trend of cocoa beans (1961-2017)



From pre-SAP to SAP periods, the area had a flat trend due to insignificant annual incremental change in the area while during the post-SAP period the area trend sharply inclined. Furthermore, for the yield trend, it exhibits a series of cyclical trends from the pre-SAP period through to the post-SAP period. Therefore, it can be suggested that the first cyclical production trend which persists from the early sixties to late seventies was driven by steep upward and downward swings of the yield trend as annual change in area was stagnant, and thereafter the production trend troughed from the late seventies till the mid-eighties and is attributed to sharp decline in the annual yield which hovers till 1985.

Afterward, the production trend initiated a recovery, which was driven by both annual incremental rise in area, and yield, passed through the prosperity stage, then peaked at the year 2006 and thereafter plummeted due steep decline in both area and yield till it reaches the ebb of the second phase cycle (Figure 2 to 4).

Figure 2. Pre-SAP production trend of cocoa beans (1961-1984)

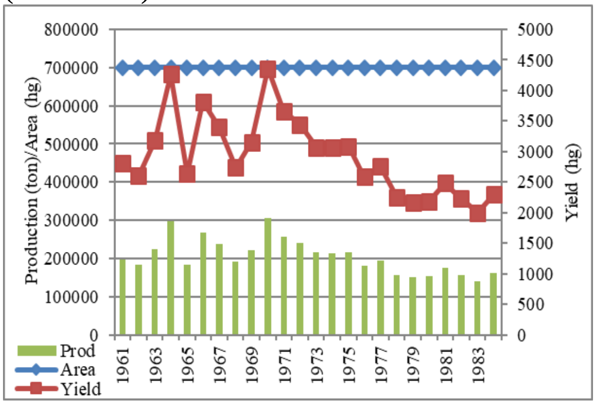


Figure 3. Pre-SAP production trend of cocoa beans (1985-1999)

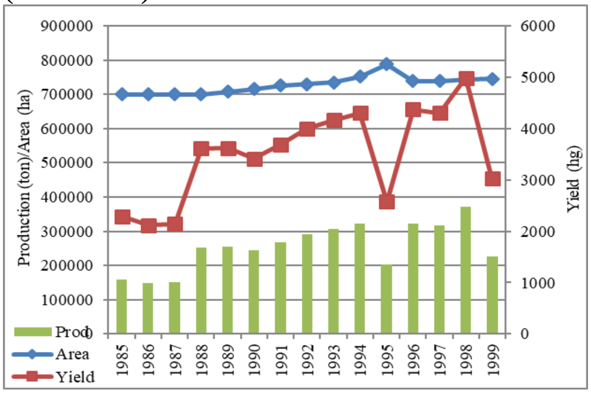
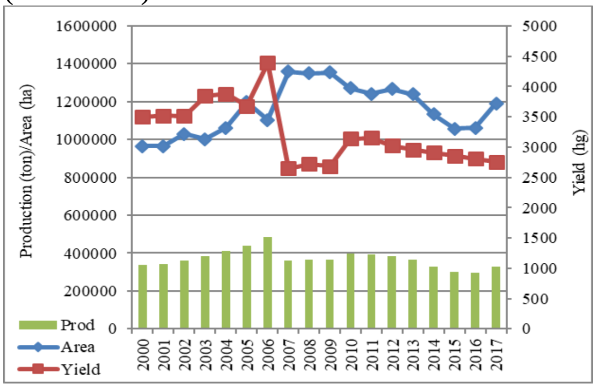


Figure 4. Pre-SAP production trend of cocoa beans (2000-2017)



Yield has been majorly responsible for the annual incremental changes in the cocoa beans production in Nigeria, reflecting the impact of technology *viz.* use of improved varieties as there was no area expansion *viz.* establishment of new plantations until during the post-SAP period.

The steady demand for cocoa beans in the world made it to be the most valued cash crop in Nigeria, thereby encouraging the government to invest in technology to boost the output of cocoa beans for exportation to Europe and America.

The results of the annual average of cocoa beans production across the policy regimes showed the incremental change in the production from pre-SAP to SAP and then SAP to post-SAP to be very moderate. The same pattern was observed for the average annual yield across the policy periods (Table 3). However, the average annual area level showed a marginal change from pre-SAP to SAP and thereafter surged by almost two-fold from the SAP period to the post-SAP period. This outcome validates the cocoa beans production trend which was observed in the earlier submission. For the growth pattern, empirical evidence showed that the production of cocoa beans during the pre-SAP era troughed i.e. recorded negative growth rate which owed to negative yield growth and no growth in area (Table 3).

During the SAP period, there was a strong recovery in the cocoa beans production as it recorded a positive growth rate of 4.5% which owed to significant incremental growth in yield (3.9%) and a marginal adjustment in area (0.6%). For the post-SAP period, a similar scenario which occurred in the growth pattern of cocoa beans production during the pre-SAP regime was observed i.e. a negative growth (-1.0%)in the production which was caused by a negative yield growth (-1.9%). However, the area observed a marginal positive growth (0.9%) but it was insignificant to warrant desired growth in cocoa beans production during the stipulated policy period. The poor production performance observed during the pre-SAP and post-SAP is as a result of failure to replace the old plants and establish new ones: degeneration of the old plants given that the plantations have outlived their useful life span, thus the reason for the low productivity. Generally, the growth pattern of cocoa beans production for the overall period recorded a positive growth rate (1.3%) which was largely influenced by positive growth in area (1.2%) as the incremental growth rate of yield was marginal (0.2%). Therefore, it can be concluded that the cocoa beans production performance in the country was not impressive throughout the policy regimes despite that it was a remunerative cash crop that fetched the country's foreign exchange earnings during the pre-SAP. The favorable exchange rate, the balanced term of trade and comparative advantage were the major factors that made the country to generate remunerative revenue from cocoa beans during the pre-SAP period as the growth was not a healthy one. However, the sub-sector performed well in the subsequent period owing to the liberalization policy and replenishment of the old plants with establishments of new plantations.

Table 3. Growth pattern of cocoa beans production

Variables	Pre-SAP	SAP	Post-SAP	Overall
Area (ha)	700000.00 (0.00)	727900.00 (0.6)***	1158722.00 (0.9)*	852201.70 (1.2)***
Yield (hg)	2926.22 (-1.9)***	3506.20 (3.9)**	3221.11 (-1.9)***	3171.93 (0.2)^{NS}
Production (ton)	204833.3 (-1.9)***	255933.3 (4.5)***	369584.9 (-1.0)*	270307.5 (1.3)***

Source: Authors' computation, 2019
Figure in parenthesis is CAGR
*** ** *significant at 1%, 5%, 10% respectively, ^{NS} Non-significant

3.2. Magnitude and sources of instability

The results of the CV index showed the magnitude of production instability during the pre-SAP and SAP to be moderate (between 20 and 39%),and it owes largely to shock in yield as area witnessed a marginal shock during the SAP era and no shock during the pre-SAP era (Table 4).

Also, for the overall period, the fluctuation in the cocoa beans production was moderate and it was due to both moderate shocks observed in area and yield. Although, the extent of instability in the cocoa beans production during the post-SAP era was observed to be low and this is due to low fluctuation in both area and yield. Furthermore, examining the exact direction of the instability in the cocoa beans production, the results showed the magnitude of instability across the three regime periods to be low as indicated by their respective CDII indexes which were less than 20% (Table 4).

The low fluctuation in area across the regime periods played a significant role in making the impact of the shock felt by the production to be low. However, for the overall period, the production instability was moderate which largely is caused as a result of a slight steep shock observed by the yield. A review of the instability based on year-to-year variability and its relation to price trend, the empirical evidence showed variability in the production of cocoa beans across the policy regime periods and even the overall period to be very high, with wide annual variability in the yield been the major causal factor (Table 4). Therefore, it can be suggested that the price of cocoa beans was not stable throughout the studied period in the local and international markets, thus causing wide variability in the cocoa beans production in the country.

Table 4. Magnitude of instability in cocoa beans production (%)

Regimes	Variables	CV	CDII	CII
Pre-SAP	Production	22.26	17.216	45.69
	Area	0.00	0.00	36.79
	Yield	22.26	17.21	45.69
SAP	Production	26.80	19.43	49.31
	Area	3.42	2.01	38.06
	Yield	25.64	20.03	48.62
Post-SAP	Production	12.62	11.47	41.62
	Area	11.53	10.46	41.31
	Yield	15.53	11.52	42.73
Overall	Production	32.58	24.37	51.51
	Area	26.20	14.59	46.60
	Yield	22.49	22.33	46.08

Source: Authors' computation, 2019

The results of the source of instability between regimes showed "change in yield variance" to be the major source of fluctuation in cocoa beans production between the pre-SAP and SAP periods, while between the SAP and post-SAP regime shifts, production variability was largely due to "interaction between changes in mean area and yield variance" and "change in yield variance" (Table 5). This showed that instability in the cocoa beans production between the regime shifts which transit the economy was largely due to risk *viz.* production risk, technology risk, policy risk and market risk. However, for the overall regime shifts, "change in yield variance" and "change in residual" were the source of production instability. Therefore, it can be inferred that the effects of risk and uncertainty persist across the regime shifts in causing variability in the cocoa beans production of Nigeria during the stipulated periods under review.

Table 5. Sources of instability in cocoa beans production (%)

Source of variance	Pre-SAP to SAP	SAP to Post-SAP	Overall
Change in mean yield	0.00	-26.15	0.00
Change in mean area	4.15	-144.40	17.36
Change in yield variance	51.07	83.90	83.85
Change in area variance	2.21	-15.09	-7.57
Interaction between changes in mean yield and mean area	0.00	1.28	0.00
Change in area yield covariance	27.96	26.48	15.38
Interaction between changes in mean area and yield variance	4.15	128.70	-52.09
Interaction between changes in mean yield and area variance	0.96	2.35	7.50
Interaction between changes in mean area and yield and change in area-yield covariance	6.89	12.27	-16.26
Change in residual	2.61	30.67	51.84
Total change in variance of production	100	100	100

Source: Authors' computation, 2019

3.3. Changes in production

The results of the instantaneous growth decomposition showed "yield effect" to be the only source of the increase in the average production level during the pre-SAP period as there was no contribution from 'area effect' and 'interaction effect'. To the best of the knowledge of the researchers, the literature review did not reveal a similar scenario of "area effect" and "yield effect" been zero. During the SAP period, incremental growth in the average annual production level was stimulated by "yield effect" and "area effect", while the "interaction effect" exerted a smaller proportion of decrease in the annual average production level. However, the influence of "yield effect" was more pronounced, thus making it the major source of the increase in the average annual output for the stipulated period. During the post-SAP period, the influence of "area effect" caused a serious decline in the annual average production level of cocoa beans production which might be due to non-replenishment of the old plantation with new ones and the shrinking of arable land due to pressure which owed to competing demand for land for other purposes *viz.* urbanization, industrialization etc. However, "yield effect" and "interaction effect" played a role in bringing about incremental changes in the average annual production but the effect of "area effect" in affecting the annual average output level was more pronounced. For the overall period, the 'area effect' was found to be the major source of incremental change in the level of cocoa beans production in the studied area (Table 6).

Furthermore, the results of the inter-regime source(s) of change in the average annual production level between pre-SAP and SAP periods showed 'change in average yield' to be the major source that made the annual average production level of SAP to exceed that of pre-SAP. While between the SAP and post-SAP regime shifts, 'change in average area' was the major factor responsible for the surge of the average annual production level of the post-SAP period over that of the SAP period (Table 7).

Table 6. Sources of change in cocoa beans production (Intra-wise %)

Source of change	Pre-SAP	SAP	Post-SAP	Overall
Area effect	0	38.57446	-1202.68	159.3108
Yield effect	99.97238	83.85262	702.3042	-11.6762
Interaction effect	0	-22.4765	600.8056	-47.6483
Total change	100	100	100	100

Source: Authors' computation, 2019

Table 7. Sources of change in cocoa beans production (Inter-regime wise %)

Source of change	Pre-SAP to SAP	SAP to Post-SAP
Change in Mean yield	79.16	-17.72
Change in Mean Area	15.92	128.99
Interaction between changes in mean area and mean yield	3.15	-10.49
Change in yield and area covariance	1.77	-0.78
Total change	100	100

Source: Authors' computation, 2019

3.4. Farmers' acreage response

The results of the OLS estimation showed the linear regression functional form to be the best fit for the specified dynamic regression model as it satisfied the criteria of economic theory, statistical properties and econometric principles, thus chosen as the lead equation among all the tried functional forms (Table 8).

The diagnostic test statistics results showed the residual to be devoid of serial correlation, heteroscedasticity and Arch effect as revealed by the Durbin-Watson (DW) test, Langrage Multiplier (LM) test and ARCH LM test statistics respectively, which were not different from zero at 10% degree of freedom. Also observed were that the model specification was adequate, there is no structural break in the data despite the different regimes and the parameter estimates were stable as indicated by the CUSUM test, Chi^2 test and the RESET test statistics respectively, which were not different from zero at 10% degree of freedom. The result showed evidence of no spurious regression as the coefficient of multiple determination is lower than the DW statistic. However, the residual was found not to be normally skewed as indicated by the Chi^2 test statistic, which was different from zero at 10% degree of freedom. Though, the literature has revealed that non-normality of residual is not considered a serious problem, as data in their natural form are not normally distributed.

The coefficient of multiple determination (R^2) being 0.9530 implies that 95.30% of the variation in the current acreage was influenced by the institutional and non-institutional factors captured by the model. The empirical evidence showed that the current acreage cultivated under cocoa beans was being determined by lagged yield, lagged owned price, weather index, lagged price risk, time index and lagged area as indicated by their respective coefficients, which were different from zero at 10% degree of freedom.

The positive significance of the lagged yield implied that the bumper harvest of cocoa beans encouraged farmers to increase the current acreage cultivated under cocoa beans. This showed the suitability of the cocoa beans improved varieties used among the producers in the country.

However, poor weather conditions owing to weather vagaries affected the current acreage cultivated under cocoa beans as indicated by the negative significant of its estimated coefficient. Therefore, the research institutes should develop improved varieties that have qualities of resistance to poor weather conditions. The positive significance of the lagged owned price of the product showed that the farmers still have a control on the price of their commodity which may owe to co-operative marketing i.e. bargaining power thereby making them price-giver and not price-takers in the cocoa beans commodity market, thus yielded them remunerative price in the cocoa market. This is contrary to the poor price narrative of cocoa farmers in the neighboring Africa cocoa-producing nations. This clearly showed that the quality of the cocoa beans produced in the country is of high standard i.e. preferred market category. In addition, it indicates that the product is produced on a commercial basis and not at a subsistence level. Therefore, government price policies on the licensed buyers' organization (LBOs) were in the right direction to bring about the desired goal of attaining high cocoa beans production in the country. This favorable price factor encouraged the farmers to increase the current acreage cultivated under cocoa beans in the country. In the short-run, the farmers were inelastic in their acreage response to owned price change: the responsiveness of acreage to price is marginal. Also, in the long-run, the farmers' response to a price change if given sufficient time for adjustment is small, thus indicating that the impact of price policy on cocoa beans in the long-run would be mild. Furthermore, it was observed that it took the crop small time (2.18 years) to adjust to price effect i.e. the price effect to materialize, thus indicating that the farmers faced less technological and institutional constraints.

The negative significance of the lagged price risk coefficient revealed that the farmers were risk-averse to shock in the price of cocoa beans owing to their poor investment capital base, thus impacting negatively on the current acreage cultivated under cocoa beans in the country. The fear of loss of farm financial capital with damning consequences on production and developmental finance impaired farmers' decisions on acreage allocation in the studied area. However, though non-significant, the negative sign attributed to the lagged yield risk showed an element of the farmers to be risk-takers with respect to yield variability as the fluctuation in the yield is mostly bound by weather vagaries given the confidence they have on the viability of the improved seed varieties. Furthermore, the positive significant of the time trend index showed that the various agricultural policies implemented in the country impacted favorably on the cocoa beans production in the country, thus encouraged farmers to increase the current acreage under cocoa production. This outcome did not come as a surprise as cocoa bean production is one among the many cash crops produced in the country that is given due policy attention as it is a good money-spinning export revenue commodity for the country. The result showed that the farmers are slow in the adjustment of acreage allocation under cocoa beans cultivation as indicated by the adjustment coefficient of 0.25which is low.

3.5. Production forecast of cocoa beans in Nigeria

The ADF-GLS unit root test results showed all the variables *viz.* production, area and yield to be non-stationary at level but after first difference, they became stationary as indicated by their respective tau-statistics which were greater than the tau-critical and lower than the tau-critical at 5% probability level, respectively (Table 9). Thereafter, the variables were subjected to different ARIMA levels and the empirical evidence showed ARIMA (0,1,1), ARIMA (1,1,0) and ARIMA (1,1,1) to be the best fit to forecast area, production and yield respectively, as they have the lowest Akaike information criteria (AIC). The diagnostic test results showed these chosen ARIMAs to have their residual free from serial correlation, Arch effect and normally distributed as indicated by their respective Ljung Box test, Jarque-Bera test and the Arch-LM Chi^2respectively, which were not different from zero at 10% degree of freedom. However, the residual of area was not normally distributed and it should not be considered a serious problem.

To validate how closely the sample periods could track the path of actual observation, one-step-ahead forecast of the variables along with their corresponding standard errors using the naïve approach for the periods 2013 to 2017 were computed to determine the predictive power of the selected ARIMAs (Table 10). The results of the Relative mean absolute prediction error (RMAPE) and Theil's inequality (U) coefficients were less than 5% and 1 respectively, thus indicating the reliability of the selected ARIMAs. In addition, the predictive error associated with the estimated equations in tracking the actual data (*ex-post* prediction) is very low and insignificant, therefore it could be used for *ex-ante* projection with high projection validity, efficiency and consistency (Table 11).

Table 8. Farmers' acreage response

Variables	Parameters	t-stat	Mean	SRE	LRE
Intercept	82342.2 (77824.4)	1.058^{NS}	-	-	-
P_{t-1}	0.604376 (0.34271)	1.764*	45573.45	0.031775	0.125533
PR_{t-1}	-2.44863 (0.83445)	2.934***	6652.789	-0.01879	-0.07424
Y_{t-1}	25.6913 (13.7054)	1.875*	3118.906	0.092438	0.365196
YR_{t-1}	0.419019 (0.4218)	0.993^{NS}	248300.7	0.120026	0.474187
T_t	1322.12 (555.123)	2.382***	26	0.039656	0.156669
WI_t	-88693.6 (43946.9)	2.018**	0.981123	-0.10039	-0.3966
A_{t-1}	0.746881 (0.1075)	6.948***	850481.1	0.732789	2.895037
R^2	0.9530				
F-stat	439.63{7.47e-38}***				
DW test	2.518{0.8845}^{NS}				
Arch effect	1.9287{0.1648}^{NS}				
Heteroscedasticity	1.2484{0.856}^{NS}				
Normality	14.105{8.6e-4}***				
CUSUM test	0.3977{0.6928}^{NS}				
Chow test	0.5524{ 0.4614}^{NS}				
RESET test	0.40735{0.526}^{NS}				

Source: Authors' computation, 2019, *** ** *significant at 1%, 5%, 10% respectively, ^{NS} Non-significant
Values in ( ), [ ] and { } are standard error, t-statistic and probability level respectively

Table 9. ARIMA model

ARIMA		Production (AIC)	Area (AIC)	Yield (AIC)
ARIMA (1,1,1)		1367.379	1393.09	881.522
ARIMA (1,1,0)		1367.491	1391.716	883.865
ARIMA (0,1,1)		1365.436	1391.997	879.525
Autocr.	Ljung-Box	11.96 (0.609)^{NS}	16.8351 (0.2651)^{NS}	14.449 (0.343)^{NS}
	Portmanteau	9.782(.777)^{NS}	13.92 (0.4551)^{NS}	11.330(0.583)^{NS}
Arch effect		3.366 (0.498)^{NS}	1.1779(0.8817)^{NS}	2.245 (0.6907)^{NS}
Normality		0.609 (0.737)^{NS}	127.52 (0.00)***	1.184 (0.553)^{NS}
ADF	Level	-2.102 {-3.03}	-1.679 {-3.03}	-2.259 {-3.03}
	1st Diff.	-11.148{-3.03}	-4.369 {-3.03}	-11.356 {-3.03}

Source: Authors' computation, 2019, *** significant at 1% probability respectively, ^{NS} Non-significant
Values in ( ) and { } are standard error and t-critical value at 5% probability level respectively.

Table 10. One-step ahead forecast for cocoa beans production

Period	Production		Area		Yield	
	Actual	Forecast	Actual	Forecast	Actual	Forecast
2013	367000	390074.8	1239750	1253759	2960	3047.03
2014	329870	380225.3	1134047	1231926	2909	3005.84
2015	302066	356174.8	1057174	1136487	2857	2960.54
2016	298029	330170.5	1062186	1060029	2806	2912.3
2017	328263	315601.3	1191812	1057688	2754	2862.88

Source: Authors' computation, 2019

Table 11. Validation of models

Variable	R^2	RMSE	RMSPE	MAPE	RMAPE (%)	Theil's U
Production	0.923738	36487.84	4266.807	-24788.8	-8.02112	1.004300
Area	0.992804	82298.09	5899.349	-8182.01	-0.93527	1.002473
Yield	0.970911	93.00867	3.061545	-83.112	-2.93898	1.000553

Source: Authors' computation, 2019

The result of the one-step-ahead out-of-sample forecast for the period 2018 to 2029 showed an un-impressive production trend for cocoa beans due to the plummeting trend of yield in the future (Table 12). This shows that the future production trend of cocoa beans in Nigeria will be driven by a marginal increase in the annual area, which will exhibit arithmetic rise, thus forcing the production trend to increase in an arithmetic manner. Therefore, since empirical evidence shows that the future annual yield can be doubled (upper boundary limit), it becomes very pertinent for policymakers to invest on improved technologies which will enhance the productivity of this cash crop which play a very vital role in foreign exchange earnings for the country.

Table 12. Out of sample forecast of the variables

Year	Production			Area			Yield		
	Forecast	LCL	UCL	Forecast	LCL	UCL	Forecast	LCL	UCL
2018	326514.72	223212.41	429817.02	1193472.44	1041032.02	1345912.85	2810.43	1489.06	4131.81
2019	328676.13	214893.59	442458.67	1201590.54	1018526.26	1384654.82	2807.85	1383.64	4232.06
2020	330837.54	207461.82	454213.25	1210171.90	1001105.44	1419238.36	2805.26	1285.18	4325.33
2021	332998.95	200723.98	465273.92	1218684.10	986484.41	1450883.78	2802.66	1192.43	4412.90
2022	335160.36	194548.24	475772.48	1227206.62	973981.69	1480431.55	2800.07	1104.46	4495.68
2023	337321.77	188839.89	485803.65	1235727.60	963093.61	1508361.59	2797.48	1020.58	4574.37
2024	339483.18	183528.16	495438.20	1244248.81	953498.61	1534999.02	2794.88	940.27	4649.50
2025	341644.59	178558.51	504730.67	1252769.99	944967.98	1560572.00	2792.29	863.09	4721.50
2026	343806.00	173887.87	513724.12	1261291.17	937333.65	1585248.69	2789.70	788.68	4790.72
2027	345967.41	169481.52	522453.30	1269812.35	930467.59	1609157.12	2787.10	716.76	4857.45
2028	348128.82	165310.96	530946.68	1278333.53	924269.60	1632397.46	2784.51	647.09	4921.93
2029	350290.23	161352.49	539227.97	1286854.71	918659.57	1655049.85	2781.92	579.47	4984.37

Source: Authors' computation, 2019

4. Conclusion and Recommendations

It can be inferred that yield played a major role in driving the Nigerian cocoa beans production until during post-SAP period where area effect owing to the replenishment of old plants with newly established ones surged to become the major driving force of incremental change in the production trend of cocoa beans. Furthermore, the findings showed annual variability in the production growth to be caused by institutional and technological risks, and the farmers were apprehensive about market risk owing to their poor capital base. The future of the cocoa beans production will not be impressive as the predicted annual yield will be declining owing to aging of the existing plantation and possible climate change effect. Therefore, the onus lies on the policymakers to contribute to replenishing this plantation as time passes and the need for more investment in research technologies especially climate-smart agriculture to attain desireable high productivity as this cash crop stands a better chance to shore-up the revenue deficit affecting the nation's economy.

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