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Effects of Fluctuations in Cocoa Price on its Production and Export in Nigeria: A Nonlinear AutoRegressive Distributed Lag Approach

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Abstract

The study examined the influence of prices on cocoa production and exports in Nigeria. The variables under review included key aspects of cocoa production such as Cocoa Output (CO), Yield (YE), Area Harvested (AH), and Cocoa Export (CEX), as well as cocoa World Price (WP) and Producer Price (PP). Secondary data spanning from 1980 to 2020 were sourced from reputable national and international sources such as the Food and Agriculture Organization (FAO), quarterly bulletin of cocoa statistics, and World Bank commodity price data (the pink sheet), among others. Analytical tools employed in the study included descriptive statistics, a growth function model and graphs and a Nonlinear Auto-Regressive Distributed Lag (NARDL) model. The result of the growth function analysis indicated a slow growth rate in YE, CO, AH and CEX while WP and PP have a relatively faster growth rate. The result also confirmed significant acceleration in WP, PP, CO, AH and CEX while for YE, there is stagnancy. The influence of WP and PP on cocoa production and exports in Nigeria was examined using a novel cointegration technique, NARDL. The findings indicated that both positive and negative decomposed partial sums of PP and WP had insignificant effects on CO, while they had significant effects on CEX. Based on these results, the study concluded that prices of cocoa had significantly impacted CEXs in Nigeria. Cocoa farmers are encouraged to step up their game to achieve increased production and export so as to benefit more from the upward trend of cocoa prices. It is also recommended that the government should introduce price-related reforms that will improve the transmission of WPs to farmers and ensure transparency and accountability in implementing such reforms.

Keywords: Fluctuations, Cocoa price, Cocoa production, Cocoa export, ARDL.

1 | Introduction

Cocoa production in West Africa, particularly in Nigeria, dates back to the 1870s, with Bonny and Calabar farms being the earliest cocoa farms in Nigeria. After that, it spreads to some other areas in the Yoruba land, including Ibadan, Egba, Ilesha, Oke-Igbo, Ondo town, Ife, Gbongan and Ekiti land in the 1890s [1]. Nigeria

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became one of the largest producers of cocoa in West Africa in the early 1920's. Its production peaked in the 1950s and 1960s, making its export so prominent and significant to the country's agricultural exports during this period as it accounted for nearly half of the nation's total agricultural exports [1]. Cocoa production in Nigeria has a chequered history with some of its challenges, including the discovery and exploitation of oil that led to neglect of the entire agricultural sector, low yields, inconsistent production patterns, disease outbreaks, pest infestations, and reliance on rudimentary farm tools, ageing cocoa farms and cocoa farmers themselves and inefficient marketing channels amongst other factors [2]–[4].

Crop production relies on the availability of arable land and is affected in particular by yields, macroeconomic uncertainty, as well as consumption patterns; it also has a great incidence on agricultural commodities prices. The importance of crop production is related to areas harvested, returns per hectare (yields) and quantity produced. Crop yields are the harvested production per unit of harvested area for crop products, while crop production is the yields harvested per unit of harvested area for crop products. Yield is calculated by dividing production data by the data on Area Harvested (AH) [5]. Cocoa production in Nigeria was considered in this article in the context of these three key determinants of crop production i.e. cocoa production quantity or output, its yield and AH. Cocoa Export (CEX) within the stipulated period was also reviewed.

The term' Producer Price' (PP) in agriculture refers to the amount a producer receives from a purchaser for a unit of a good or service produced, minus any VAT or similar deductible taxes invoiced to the purchaser [6]. World Price (WP), on the other hand, is the price of a good or service in all countries except one's own. It influences international trade [7].

Price fluctuations can be simply put as the frequent rise and fall in prices of goods and services in the market. Price fluctuations can take place in any market, be it local or international [7]–[9].

There have been quite a few research works on the effects of price fluctuations on agricultural export crops. Ebi and Ape [11] studied the supply response of seven agricultural export commodities (cocoa, benniseed, rubber, palm oil, groundnut, cotton seed, and soybeans) from Nigeria, spanning from 1970 to 2010. They employed an econometric Error Correction Model (ECM) to analyze the export supply behaviours of these commodities. Their findings indicated varied responses among individual commodities to price and non-price variables. Mesike et al. [12] examined the short-run and long-run supply responses of cocoa in Nigeria to price changes and other factors. They employed a single supply response function and incorporated cointegration and Vector Error Correction (VEC) procedures in their analysis. Overall, their study revealed positive supply responses from cocoa growers in Nigeria to changes in incentives.

Darkwah and Verter [13] analyzed cocoa production in Ghana from 1990 to 2011, employing Johansen cointegration and OLS regression methods. The cointegration test results revealed a long-run equilibrium relationship between cocoa bean production, AH, WP, CEXs, and Real GDP Per Capita (RGDPC), all of which were statistically significant. Gama et al. [14] conducted a study to assess the impact of CEX volume and cultivated area on changes in cocoa PPs using data spanning from 1970 to 2018. They employed unit root tests, cointegration tests, and vector ECMs to analyze the data. Results from the Vector ECM revealed that cocoa PPs adjusted slowly to changes in both CEX volume and area under cocoa production.

In the short run, the analysis indicated a positive response of PPs to CEXs, while the AH showed a significant negative relationship with PP variations, on average. Essien et al. [15] conducted a study examining the impacts of price and exchange rate fluctuations on agricultural exports, specifically cocoa, in Nigeria. The findings indicated that exchange rate fluctuations and agricultural credits had a positive effect on CEXs in Nigeria. Additionally, the study found that while relative prices of cocoa were not significantly related to the quantity of exports, they exhibited a negative sign. Hualin and Bohan [16] investigated the impact of price fluctuations in agricultural produce on grain production in China in their study. They applied the cobweb theory and VEC model to analyze the data. Their findings indicated that fluctuations in agricultural product prices significantly influenced changes in grain production.

Of all the literature reviewed, none of them holistically considered the effects of fluctuations in the prices of cocoa on its production (with regards to its yield, production quantity and AH) and export. This study addressed this gap. Effects of both prices, i.e. WP and PP, on cocoa production and export, were evaluated, and data put to use were more recent. The study also particularly took advantage of the Nonlinear Auto-Regressive Distributed Lag (NARDL) cointegration technique to fathom more than the linear relationship between the variables under consideration.

This research work carried out a trend and growth analysis on the variables to determine their growth over the study period. It employed the NARDL cointegration technique in its analysis to determine the effects of fluctuations in prices (world and PPs of cocoa) on outputs, yield, AH and export in Nigeria. It recommended some measures by which cocoa farmers can step up their game to achieve increased production and export so as to benefit more from the upward trend of the cocoa price.

2|Literature Review

Cocoa was a major contributor to the Nigerian economy until the early 1970's boom in crude oil exploration [3], [17]. Amongst agricultural commodity exports of the country, cocoa cannot be ignored even despite the challenges that led to a decline in its production and contribution to the national GDP in the past years. This is due to the fact that its export remains pivotal to the agricultural sector of the nation [18], [19].

Fluctuations of agricultural commodities

Price fluctuations of agricultural commodities are a multi-faceted problem caused by a combination of various factors which may have grave consequences for the most vulnerable. When it comes to the detrimental effects of price fluctuations, both consumers and producers are affected. Small-scale farmers, in particular, often lack sufficient investment capital to withstand such price unpredictability, leading to suboptimal investment choices and potentially jeopardizing long-term production. Consumer purchasing power is also eroded as a result of the fluctuations [20].

Table 1. Cocoa production and export in Nigeria with key indicators.

Year	Production Quantity (Ton)	Yield Hectogram/Hectare	AH (Hectares)	Export/Qty (Ton)
1980	153,000	2186	700,000	124,500
1981	174,000	2486	700,000	138,000
1982	156,000	2229	700,000	75,900
1983	140,000	2000	700,000	114,900
1984	160,800	2297	700,000	208,800
1985	160,000	2286	700,000	97,900
1986	148,000	2114	700,000	104,300
1987	150,000	2143	700,000	58,700
1988	253,000	3614	700,000	80,800
1989	256,000	3616	708,000	141,300
1990	244,000	3413	715,000	135,000
1991	268,000	3691	726,000	142,000
1992	292,000	4000	730,000	96,000
1993	306,000	4163	735,000	141,300
1994	323,000	4301	751,000	132,200
1995	203,000	2576	788,000	146,754
1996	323,000	4371	739,000	136,917
1997	318,000	4303	739,000	136,601
1998	370,000	4980	743,000	128,065
1999	225,000	3022	744,000	208,617
2000	338,000	3499	966,000	144,821
2001	340,000	3520	966,000	184,122
2002	362,000	3515	1,030,000	191,922
2003	385,000	3842	1,002,000	241,847
2004	412,000	3879	1,062,000	266,027
2005	441,000	3678	1,198,902	281,620
2006	485,000	4393	1,104,000	181,852
2007	360,570	2652	1,359,550	190,925
2008	367,020	2720	1,349,130	200,449

Table 1. Continued.

Year	Production Quantity (Ton)	Yield Hectogram/Hectare	AH (Hectares)	Export/Qty (Ton)
2009	363,510	2684	1,354,340	210,448
2010	399,200	3137	1,272,430	220,947
2011	391,000	3150	1,241,329	231,969
2012	383,000	3024	1,266,347	159,738
2013	367,000	2960	1,239,750	203,842
2014	329,870	2882	1,144,659	163,536
2015	302,066	2858	1,056,893	131,199
2016	298,029	2841	1,048,945	227,495
2017	325,000	2815	1,154,654	292,872
2018	340,000	2780	1,222,844	294,661
2019	348,448	2739	1,272,382	300,472
2020	340,163	2697	1,261,406	216,676

*Source: computed from FAOSTAT, 2022
Food and Agriculture Organization (FAO) production yearbook (various issues)
NCB: cocoa statistics (various issues)
https://www.statista.com/statistics/1298751/annual-cocoa-beans-export-volume-in-Nigeria/

Table 2. Cocoa PPs and WPs in Nigeria (1980-2020).

Years	WP ($/Kg)	PP/ Tonne (Naira)	WP/Tonne (Naira/ Tonnes)
1980	2.60	1,300	1,421.6
1981	2.08	1,300	1,284.8
1982	1.74	1,300	1,171.8
1983	2.12	1,400	1,535.7
1984	2.40	1,500	1,839.7
1985	2.25	1,500	2,010.9
1986	2.07	3,500	3,631.9
1987	1.99	8,000	7,991.9
1988	1.58	11,000	7,168.4
1989	1.24	10,100	9,132.3
1990	1.27	8,500	10,208.6
1991	1.20	10,158	11,891.4
1992	1.10	12,745	19,028.3
1993	1.12	25,278	24,713.2
1994	1.40	61,180	30,7944
1995	1.43	82,674	31,310.2
1996	1.46	80,222	31,951.3
1997	1.62	89,687	35,455.4
1998	1.68	79,600	36,768.5
1999	1.14	85,766	105,266.1
2000	0.91	83,818	95,544.5
2001	1.07	91,300	119,017.5
2002	1.78	129,620	214,629.2
2003	1.75	153,749	226,139.2
2004	1.55	186,870	205,976.4
2005	1.54	225,309	202,162.4
2006	1.59	243,175	204,556.2
2007	1.95	267,435	245,325.8
2008	2.58	305,934	305,902.1
2009	2.89	410,000	430,263.2
2010	3.13	443,175	470,431.2
2011	2.98	434,260	458,510.3
2012	2.39	372,400	376,425.0
2013	2.44	383,550	383,840.6
2014	3.06	482,687	485,170.9
2015	3.14	601,300	604,262.5
2016	2.89	720,800	732,591.9
2017	2.03	618,466	620,753.9
2018	2.29	698,900	700,931.7
2019	2.34	716,520	718,195.1
2020	2.37	847,200	850,381.6

*Data Source:
WP: World Bank Commodity Price Data (The Pink Sheet).
Updated on December 02, 2022.
PP: FAOSTAT Domain

Possible causes of fluctuations in WP of cocoa

Several factors can be responsible for the fluctuations in the WP of cocoa, as reported by different researchers. Some of these factors range from the force of demand and supply to population growth, civil unrest and the influence of macro-economic drivers [19]–[22].

3 | Review of the Concepts of Nonlinear Autoregressive Distributed Lag Techniques of Cointegration

Although the standard ARDL model (referred to as Linear ARDL) allows for the examination of long-run relationships among time series variables, it assumes linear or symmetric relationships between them. Consequently, the linear ARDL model and other methods that assume symmetric dynamics cannot account for potential nonlinearity or asymmetry inherent in these relationships. The NARDL model is specifically designed to address this limitation by capturing both short-run and long-run asymmetries in the variables of interest while retaining all the advantages of the linear ARDL approach [25].

In the N-ARDL model, asymmetric or nonlinear explanatory variables are disaggregated into their positive and negative partial sum series. The positive partial sum series captures the impact of the explanatory variable's increase, while the negative partial sum series reflects the impact of its decrease [26]. Similar to the linear ARDL method, Shin et al. [27] introduced the bound test to identify asymmetrical cointegration in the long run. The null hypothesis posits that the effect is symmetric in the long run, whereas the alternative hypothesis suggests that the effect is asymmetrical. The conclusion about the null hypothesis is drawn using the F-statistic and critical values. Rejection of the null hypothesis indicates the presence of an asymmetrical effect.

Once cointegration is identified, the computation process for NARDL is akin to that of traditional ARDL. Additionally, it is essential to conduct tests such as the Wald test, checking the functional form, the Lagrange Multiplier (LM) test, and using Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Square of Recursive Residuals (CUSUMSQ). These tests are crucial to verify the reliability and stability of the NARDL model [28].

3.1 | The Study Area

The study was carried out in Nigeria. Nigeria is located in sub-saharan West Africa, with an area of 923,769 square kilometres (356,669 sq. mi) and a population exceeding 225 million people. Nigeria experiences a tropical hot climate and has two distinct seasons: the dry and wet seasons, with an average yearly temperature ranging from 23°C to 31°C. Rains commence in southern Nigeria and progress northward, with the peak rainfall occurring typically in May, June, or July across most of the country [29].

3.2 | Sources of Data

This study made use of secondary data which were majorly sourced from relevant national and international bodies and websites like the FAO, Nigeria Cocoa Board Cocoa Statistics (various issues), and World Cocoa Foundation (WCF). They include yearly world and PP of cocoa, yearly production quantity (output), export quantity, AH and yield for the period under review. Annual data covering 1980 to 2020 were collected for all the variables under consideration. A nonlinear ARDL model was used in analyzing the effects of fluctuations in prices (WP and PP) of cocoa on output, yield, AH and export.

Descriptive and inferential statistical techniques were both engaged in achieving the objectives of this study. Descriptive statistics techniques used include mean, standard deviation, kurtosis and skewness, while for inferential statistics, growth function and the Nonlinear Autoregressive Distributed Lag (NARDL) cointegration technique were used. The ADF test statistics were used to ensure the time series properties of the variables to prevent spurious regression, which results from the regression of non-stationary time series data.

4 | Model Specification

4.1 | Growth Function Model

The Compound Growth Rate (CGR) was estimated by fitting an exponential function progressively to the data using the following formula:

$$Y = b_o ebt. \quad (1)$$

After linearizing in logarithm, the equation turns to

$$LogY = b_0 + b_1 t, \quad (2)$$

where Y represents the variables we examined their trend and growth (or otherwise). This includes WP, PP, Yield (YE), Cocoa Output (CO), AH, and CEX respectively.

t = time trend variable.

b_0, b_1, = Regression parameters to be estimated.

The growth rate (r) is given by

$$r = (e_1 b - 1) \times 100, \quad (3)$$

where e is Euler's exponential constant (e = 2.7183).

The data were subjected to the mentioned function to approximate trends in WP and PP from 1980 to 2020. The study also scrutinized whether there were patterns of acceleration, deceleration, or stagnation in the variables.

4.2 | Checking for Stationarity

Detection of whether a time series data exhibits a unit root or not can be illustrated by considering a variable y with a unit root, expressed through a first-order autoregressive equation AR(1) as follows:

$$Y_t = \propto Y_{t-1} + \mu t, \quad (4)$$

where

Y_t = dependent variable of choice at time t.

$\propto$= coefficient of one period lagged value of dependent variable of choice.

Y_{t-1} = one period lagged value of a dependent variable of choice.

μt = the white noise error term is assumed to be statistically independent and randomly distributed, with zero mean, constant variance, and no serial correlation.

From *Eq. (4)*, the modelling procedure for evaluation of the existence or otherwise of unit root for the time-series data is specified generally as follows:

$$\Delta Y_t = \propto_0 + \propto_2 Y_{t-1} + \sum_{i=1}^{\rho} \delta_1 \Delta Y_{t-1} + \varepsilon_i, \quad (5)$$

where

Yt = variable of choice.

$\propto_0$= intercept.

Δ = first difference operator.

$\propto_1$= (for i = 1 and 2) and δ_1(for i = 1, 2, …, p) are constant parameters.

$\sum i$ = stationary stochastic process.

ρ = number of lagged terms chosen by Akaike Information Criterion (AIC) to ensure that ε_i is white noise.

According to *Eq. (5)*, the hypotheses implied for testing the presence of a unit root would be as follows:

- *Ho: $\propto_2 = 0$, i.e. there is a unit root – the time series is non-stationary.*
- *H1: $\propto_2 \neq 0$, i.e. there is no unit root – the time series is stationary.*

For further differencing, the generalized model could be achieved through a modification of *Eq. (5)* to accommodate the second differences on lagged first as well as the k lags of the second differences as follows:

$$\Delta^2 \Psi_t = \Psi_1 \Delta \Psi_{t-1} + \sum_{i=1}^{p} \emptyset_i \Delta^2 \Psi_{t-1} + \varepsilon_t. \quad (6)$$

For the different situations, the corresponding hypotheses for testing are as follows:

- *Ho = $\Psi_1 = 0$, i.e., there is a unit root, implying that the time series is non-stationary.*
- *H1 = $\Psi_1 = 0$, i.e., there is no unit root, implying that the time series is stationary.*

4.3 | Analyzing Effects of Fluctuations in Prices (World and PPs of Cocoa) on Outputs, Yield and Export in Nigeria Using NARDL Model

Considering a simple static model that postulates a relationship between cocoa production and export in Nigeria (Y) and cocoa world (producer) price (X) of the form

$$y_t = \beta_0 + \beta_1 X_t + \mu, \quad (7)$$

where βi indicates the elasticity of cocoa production(export). *Eq. (7)* implies that fluctuations in cocoa world (producer) prices lead to a rise (fall) in cocoa production (export). In other words, under a linear and symmetric setting, production (export) responses to fluctuation in cocoa world(producer) price during a soothing period are no more than a mirror image of those during a downturn period.

To examine the impact of the two periods simultaneously, we employed an asymmetric ARDL technique (also called NARDL) developed by Shin et al. [27]. The NARDL model introduces nonlinearity by means of partial sum decompositions into the conventional ARDL model by Pesaran et al. [30]. In other words, it allows for capturing both the short-run and long-run asymmetries in the transmission mechanism by modelling the long-run relationship and the pattern of dynamic adjustment simultaneously in a coherent manner.

The first step in the asymmetric cointegrating relationship under the NARDL specification by Shin et al. [27] method is to decompose the exogenous variable in *Eq. (7)* into partial sum processes as follows:

$$y_t = \beta^+ X^+_t + \beta^- X_t^- + \mu_t, \quad (8)$$

where y_t is a $k \times 1$ vector of cocoa production (export) in Nigeria at time t; X_t is a $k \times 1$ vector of multiple regressors defined such that $X_t = X_o + X_t^+ + X_{t-}$, representing natural logarithm of cocoa producer (world) price in Nigeria; μt is the error term; β^+ and β^- are the associated asymmetric long-run parameters, indicating that cocoa production (export) in Nigeria respond asymmetrically during ups and down periods of world (producer) price. The X_t^+ and X_t^- are partial sum processes of positive (+) and negative (–) changes in X_t defined as

$$X_t^+ = \sum_{J=1} \Delta X_j^+; X_t^- = \sum_{J=1} \Delta X_j^-. \quad (8)$$

$$\Delta X_t^+ = \sum_{j=1}^{t} \max(\Delta Xj\ 0),$$
$$\Delta X_t^- = \sum_{j=1}^{t} \min(\Delta Xj\ 0), \quad (9)$$

where ΔXj are the changes in independent variables (X_t) while the '+' and the '−' superscripts indicate the positive and negative processes around a threshold of zero, which delimits the positive and the negative shocks in the independent variables. This implies that the first differenced series is assumed to be normally distributed with zero mean.

We first consider the following nonlinear ARDL (p;q) framework with which the relationships exhibit combined-long- and short-run asymmetries dynamic model

$$y_t= \sum_{j=1}^{p} \varphi_j y_{t-j} + \sum_{j=0}^{q} (\pi_j^{+\prime} X^{+}_{t-j} + \pi_j^{-\prime} X^{-}_{t-j}) + \epsilon \quad . \tag{10}$$

Thus, in line with Pesaran and Shin [31] and Pesaran et al. [30], the conditional ECM for *Eq. (10)* in terms of the positive and negative partial sums can be written as

$$\Delta yt=\rho y_{t-1} + \theta^{+} X^{+}_{t-1} + \theta^{-} X^{-}_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q-1}(\pi_j^{+} + X^{+}_{t-j} + \pi_j^{-} X^{-}_{t-}) + \epsilon_t \, . \tag{11}$$

The long-run and short-run asymmetries were also estimated using the standard Wald test. In particular, we investigated the null hypotheses of no asymmetry in the long-run coefficients ($\beta_{x^+}=\beta_{x^-}$) and in the short-run ($\pi_j^{+}=\pi_j^{-}$) in which a rejection of one or both resulted in one of the following model specifications:

I. Long-run and short-run symmetry model:

$$\Delta yt=\rho y_{t-1} + \theta X_{t-1} + \sum \varphi_j \Delta y_{t-j} \quad \sum_{j=1}^{p-1} \pi_j X_{t-j} + \epsilon_t. \tag{12}$$

II. Long-run symmetry, short-run asymmetry model:

$$\Delta y_t=\rho y_{t-1} + \theta X_{t-1} + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q-1}(\pi_j^{+} + X^{+}_{t-j} + \pi_j^{-} X^{-}_{t-}) + \epsilon_t. \tag{13}$$

III. Long-run asymmetry, short-run symmetry model:

$$\Delta y_t=\rho y_{t-1} + \theta^{+} X^{+}_{t-1} + \theta^{-} X^{-}_{t-1} + \sum_{j=1}^{p-1} \pi_j X_{t-j} + \epsilon_t. \tag{14}$$

IV. Long-run and short-run asymmetry model of *Eq. (9)*.

The asymmetric cumulative dynamic multiplier effects of a unit change in Xt on yt were obtained through the following equation:

$$m_h^{+} = \sum_{j=0}^{H} \frac{\partial y_{t+j}}{\partial X_t^{+}}.$$
$$m_h^{-} = \sum_{j=0}^{H} \frac{\partial y_{t+j}}{\partial X_t^{+}}, \quad h = 0,1,2,..., \tag{15}$$

where $h \to \infty$, $m_h^{+} \to \theta^{+}$ and $m_h^{-} \to \theta^{-}$ are the dynamic adjustment patterns.

5 | Results and Discussion

Table 3 shows the descriptive statistics of all the variables used in the study: CO, YE, AH, CEX, WP, and PP over the sample period. The results show an average CO, AH and WP of 300016.5 tons, 951,013 hectares and 226,896 naira, respectively. The Jarque-Bera estimates showed that CEX is relatively normally distributed across the period, with a kurtosis of 2.39. CO is negatively skewed with a maximum of 485000 tons and a minimum value of 140000 tons. The Table shows that all the variables are platykurtic in their distribution (light tails and fewer extreme values).

Table 3. Summary statistics of the variables.

Estimate	CO	YE	AH	CEX	WP	PP	PER
Mean	300016.5	3172.098	951013.7	172829.1	226896.0	58506.10	122.0412
Median	323000.0	3022.000	966000.0	159738.0	119017.5	8500.000	111.1000
Maximum	485000.0	4980.000	1359550.	300472.0	850381.6	750000.0	433.7000
Minimum	140000.0	2000.000	700000.0	58700.00	1171.800	736.8000	0.900000
Std. Dev.	90507.57	746.1440	245396.5	62501.89	252938.3	122413.9	117.0386
Skewness	-0.368172	0.412577	0.309062	0.371872	0.922284	4.575014	1.097557
Kurtosis	2.237586	2.335855	1.461517	2.391765	2.643657	26.17982	3.642949
Jarque-Bera	1.919275	1.916696	4.696221	1.576969	6.029414**	1060.921***	8.937839**
Probability	0.383032	0.383526	0.095550	0.454533	0.049060	0.000000	0.011460
Sum	12300676	130056.0	38991561	7085994	9302737.	2398750.	5003.690
Sum Sq. Dev.	3.28E+11	22269238	2.41E+12	1.56E+11	2.56E+12	5.99E+11	547921.2
Observations	41	41	41	41	41	41	41

*Source: author's computation, 2024
NOTE: Jarque-Bera test for normality. Null hypotheses: variables are normally distributed
***, ** and * indicates statistical significance level at 1%, 5% and 10% level respectively.

5.1 | Trend Analysis of the Variables

5.1.1 | Trend in annual cocoa yield in Nigeria (1980-2020)

The maximum yield for the period under review is 4980 kg/ha, the minimum is 2000kg/ha, and the mean is 3172kg/ha. There is irregular movement in the time plot, as shown in *Fig. 1*, depicting a non-seasonal movement of the cocoa yield. From the year 1980 to 1987, the yield oscillated between 2000 and 2500kg/ha, increased sharply from 1988-1994 and continued irregularly until 2007, when there was a sharp drop from the yield of the previous year. After that, it continues to fluctuate steadily till year 2020. The low yield from 1980-1987 may be a result of the oil discovery in the country in the 1970s and 80s, with the effort of the government concentrated more on oil than agriculture as well as the adverse effect of the Cocoa Marketing Board [32]–[34], while the rise from 1988-1994 could be as a result of the success of the Structural Adjustment Programme (SAP), introduced by then-government, on cocoa production [29]–[31].

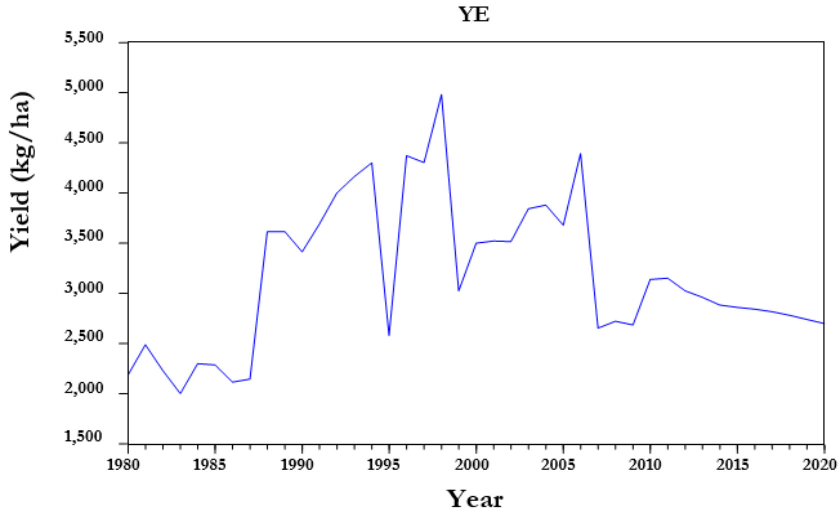
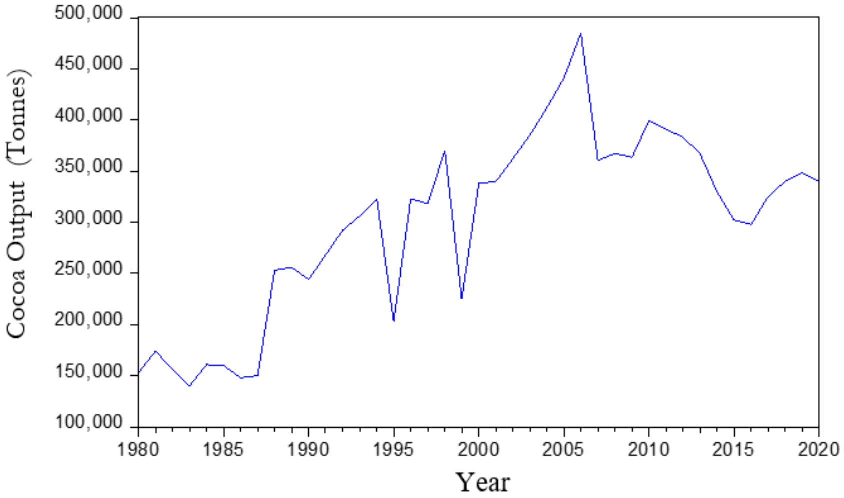


Fig. 1. Graph showing the trend in cocoa yield in Nigeria (1980-2020).

5.1.2 | The trend in annual cocoa production quantity (output) in Nigeria (1980-2020)

The trend, as shown in *Fig. 2*, revealed a low level of annual cocoa production between 1981 and 1987, which may be a result of the oil discovery in the country in the 1970s and 80s with the effort of the government concentrating more on oil than agriculture. 1988-1994 witnessed a steady rise in annual production, then a sharp decline in 1995, another sharp increase in 1996-1998, followed by another decline in 1999. Then, 2000-2006 showed a continuous rise in annual production, which may be attributable to the National Cocoa Rehabilitation Programme established in 1999 [37]. Another sharp decline from 2007-2009 indicated the poor performance of the Cocoa Rebirth Programme launched in 2005 by the federal government. A slight rise in 2010, followed by a decline from 2011-2016, and finally, a gradual rise from 2017-2020.

Fig. 2. Graph showing trend in cocoa production quantity in Nigeria (1980-2020).



5.1.2 | Trend in area of cocoa harvested in Nigeria (1980-2020)

Fig. 3 shows a fixed expanse of land (700,000 hectares) harvested from 1980 to 1988. There was a steady increase from 1989 to 1999, rising from 708,000 hectares to 744,000 hectares. It suddenly rose to 966,000 hectares in the year 2000, an appreciable increase over the past years and maintained the same figure in 2001. It hovered between 1,000,000 and 1,400,000 hectares from 2002 to 2020, with a volume of 1,002,000 hectares as the minimum within the period in the year 2003 and 1,359,550 hectares as the maximum in the year 2007. Trade liberalization policy was found to be an important driver of competitiveness, encouraging the production and export of cocoa and, subsequently, an expansion in the area of land cultivated/harvested. This may be a reasonable justification for the steady rise in AH from 1989 to 1999.

The sudden rise in the AH in the year 2000, sustained in 2001, maybe the positive response of cocoa farmers to the National Cocoa Rehabilitation Programme of the Nigerian government established in 1999 [37], which also caused the rise in cocoa production from the year 2000-2006. Ondo, Osun, Oyo, Cross River, and Ekiti are traditionally known for cocoa production in Nigeria. These states accounted for a larger percentage of the total AH, with Cross River taking the lead, followed closely by Ondo [4]. The latter entry of some other states into the cocoa production business in the country may also contribute to the increase in the AH over the years.

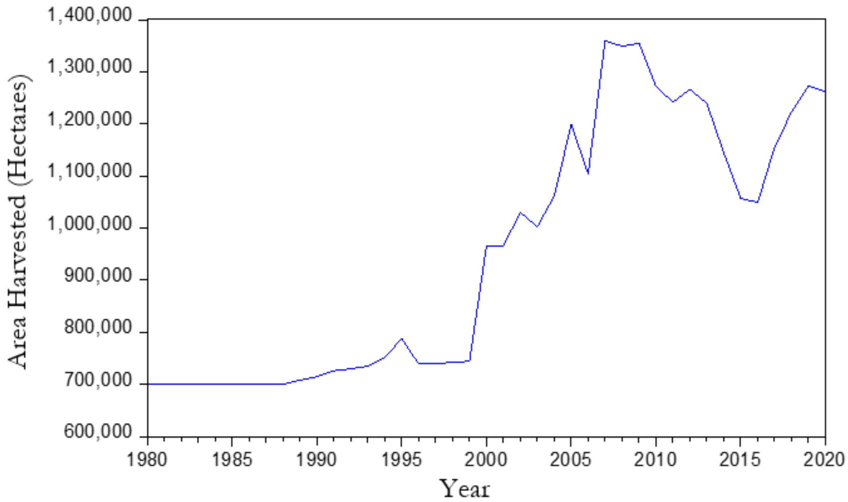


Fig. 3. Graph showing the trend in cocoa AH in Nigeria (1980-2020).

5.1.3 | The trend in cocoa PPs in Nigeria (1980-2020)

As evidenced in *Table 2* and *Fig. 4*, the PP of cocoa per tonne from 1980 to 1982 was 1300 naira. There was a slight increase of 100 naira per year from 1983 to 1985. Then a surge in price from 1986 when the PP of a tonne of cocoa rose to 3,500 naira and further rose to 11,000 naira in 1988. There was a steady fluctuation between 1989 and 1992. Then, another surge in price in 1993 when the PP rose to 25,278 naira, with the price soaring higher in subsequent years until 1998. It continued rising from the year 2001 to 2010, dropped slightly in 2011, a further drop in 2012 and continued to rise again from 2013, when the price was 383,550 naira, until 2020, when the price was 698,900 naira.

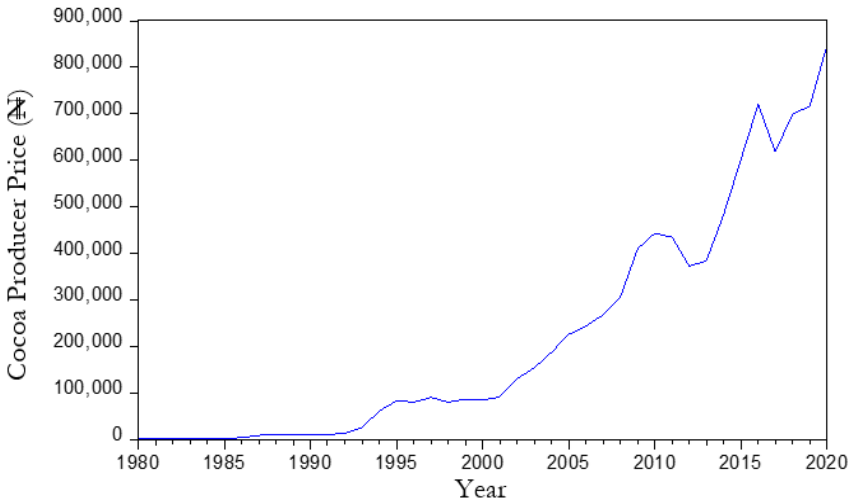


Fig. 4. Graph showing the trend in cocoa PPs in Nigeria (1980-2020).

5.1.4 | Trend in CEX in Nigeria (1980-2020)

Nigeria has a comparative advantage in the exportation of cocoa, and among the determinants highlighted to be positively significant are the world total export of cocoa (in tonnes), Nigeria's total output of cocoa (tonnes) and exchange rate (naira per US dollar) [38], [39]. *Table 1* and *Fig. 5* summarise the trend in CEX in Nigeria during the reviewed period. The export quantity kept fluctuating just as the production quantity. This can best be described as non-cyclical. Periods of rise in export quantity are 1980-1981,1983-1984, 1985-1986, 1987-1989, 1990-1991, 1992-1993, 1994-1995, 1998-1999, 2000-2005, 2006-2011, 2012-2013 and 2016-2019. Other periods experienced a decline in export quantity.

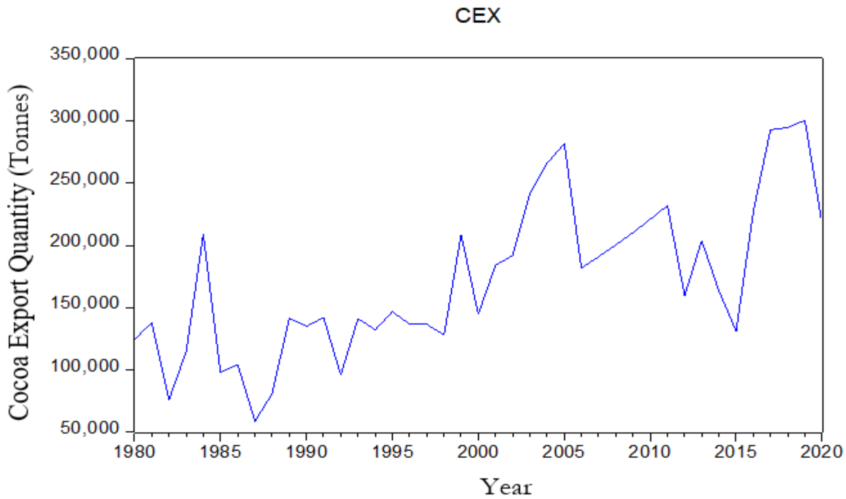


Fig. 5. Graph showing the trend in CEX quantity in Nigeria (1980-2020).

5.1.5 | Trend in cocoa WP (1980-2020)

The relative stability of the US dollar over the years has made the fluctuation in cocoa WP (in dollars) not as pronounced as when compared to the fluctuations in naira. In the whole of the four decades considered in this study, cocoa WP has a mean of 2,000 dollars/tonne with a minimum and maximum of 910 and 3,140 dollars per tonne respectively. This is in contrast to the cocoa WP in naira terms, where we have a mean of 226,896 naira/tonne, a minimum of 1,172 naira/tonne and a maximum of 850,382 naira/tonne as reflected in *Table 2* and *Fig. 6*, with the naira exchange rate being the major factor responsible for the staggering fluctuation in the cocoa WP.

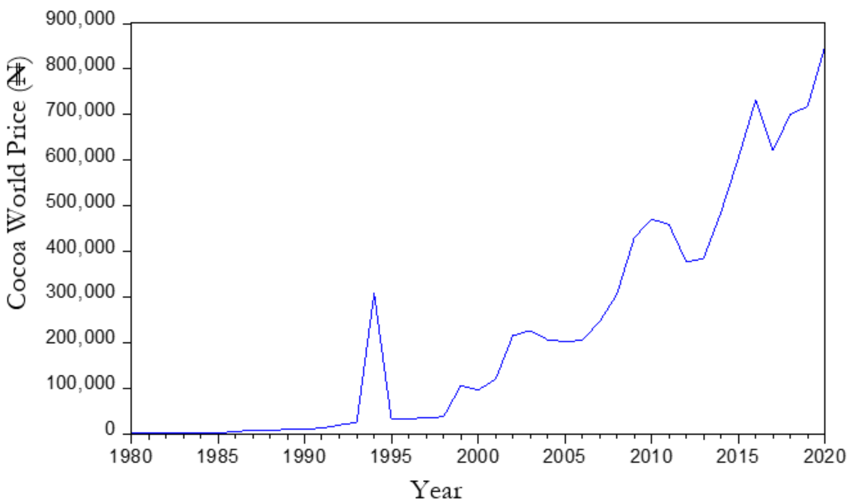


Fig. 6. Graph showing the trend in cocoa WP (1980-2020).

5.1.6 | The growth rate of the variables

Table 4 shows the estimated trend equations and the computed values of the instantaneous (annual) and CGRs of all the variables. Instantaneous Growth Rate (IGR) is the rate of growth of a variable at a point in time, while CGR is the rate of growth over a while. The IGR of 17.2% and 2.3% for WP and CEX, respectively, implies that over the period (1980-2020), the two variables increased by the different percentages per annum.

The R^2 values of 0.913 and 0.807 for WP and AH mean that approximately 91.3% and 80.7% of the variations in the listed variables were explained by variation in time. For variables with F-statistic that are significant, it implies that as a group, all the explanatory variables are jointly significant in explaining the growth rate in the variables.

Table 4. Estimated growth rate function for variables under review.

Variables/Regressor	Constant (b_o)	Coeff (b_1)/Slope	R-Square	F-Value	R (Growth Rate %)
WP	-333.395	0.172	0.913	408.18***	18.76792
PP	-252.381	0.131	0.527	43.52***	13.99688
YE	1.744	0.003	0.026	1.03	0.300452
CO	-32.14	0.022	0.591	56.39***	2.224393
AH	-24.671	0.019	0.807	163.57***	1.918178
CEX	-34.961	0.023	0.533	44.44***	2.327

*Source: author's computation, 2024

Table 5 shows the estimated quadratic equations in time variables from 1980-2020. From the result in the Table, the coefficients of t^2 for all the variables are positive, but only those for WP, PP, CO, AH, and CEX are statistically significant at 1%, meaning there is an acceleration in the growth of the variables. For YE, we can infer that there is stagnancy since their P-values are insignificant.

Table 5. Estimated quadratic equations for variables under review.

Variables/Regressor	B_0	B_1	B_2	T-Value	T^2
WP	-161.09	80.95	4.30 E-5	18.77***	20.06***
PP	-121.67	-65.52	3.27 E-5	-6.14***	6.61***
YE	4.926	265.08	7.77 E -7	1.59	1.00
CO	-9.755	180.57	5.58E -6	-3.27**	7.48***
AH	-5.469	2.56	4.80 E -6	-3.64***	12.79***
CEX	141.532	1.01	5.90 E-5	-3.67***	3.79***

*Source: author's computation, 2024

5.2 | Effects of Fluctuations in Prices on Cocoa Production

ARDL bounds testing results

As shown in *Table 6*, the value of the calculated statistic is 3.13, which is higher than the lower bound critical value of 2.56 and the upper bound critical value of 3.05 at a 5 per cent level of significance. As a result, the null hypothesis of no cointegration was rejected, which indicates that there is a long-run equilibrium relationship between the dependent variable (CO/production quantity) and the independent variables (PP and WP) in the NARDL.

Table 6. Results of f-bound test.

Critical Value	Lower Bound I(0)	Upper Bound I(0)
1%	3.29	4.37
5%	2.56	3.05
10%	2.20	2.89

*The computed F-statistics = F_{LCO}(LPP ,LWP) = 3.13
Source: Author's Computation, 2024

Analysis of the long-run estimates

As shown in *Table 7*, the long-run results of the two independent variables are splitted between the positive and negative effects. Both the positive and negative effect of WP has an insignificant effect on CO. The Same goes for PP based on their probability value, which is not significant at the 5% level.

Table 7. Long-run form of the NARDL.

Variable	Coefficient	Std. Error	T-Statistic	Prob.
WP_POS	-15.20874	40.28780	-0.377502	0.7115
WP_NEG	-15.94479	41.01138	-0.388789	0.7033
PP_POS	17.99575	46.67002	0.385595	0.7056
PP_NEG	25.78465	62.50311	0.412534	0.6862
C	-232650.2	1115806.	-0.208504	0.8378

*EC = CO - (-15.2087*WP_POS -15.9448*WP_NEG + 17.9957*PP_POS +25.7847*PP_NEG -232650.2419)
Source: Author's Computation, 2024

Analysis of the NARDL short-run estimates

The NARDL estimates in *Table 8* explain interactions between CO and two other independent variables: PP and WP in the short run. The one-period lag error correction term is statistically significant at 5%; it is negative and less than 1, thus satisfying the three criteria. Multiplied by 100, it gives us 10.0%. This is a slow speed of adjustment and implies that if there is any disequilibrium in the system, it takes an average speed of 10.0% for the nonlinear ARDL to adjust from the short run back to the long run.

Table 8. Short-run estimates of the NARDL.

Variable	Coefficient	Std. Error	T-Statistic	Prob.
D(CO(-1))	-0.837687	0.194450	-4.307978	0.0007
D(CO(-2))	-0.727654	0.214777	-3.387951	0.0044
D(CO(-3))	-0.453249	0.134442	-3.371325	0.0046
D(WP_POS)	0.067747	0.137890	0.491312	0.6308
D(WP_POS(-1))	-0.552508	0.412486	-1.339459	0.2018
D(WP_POS(-2))	-0.622520	0.438248	-1.420475	0.1774
D(WP_NEG)	1.324251	0.394227	3.359109	0.0047
D(WP_NEG(-1))	-0.810802	0.433490	-1.870405	0.0825
D(WP_NEG(-2))	-0.128702	0.159492	-0.806945	0.4332
D(WP_NEG(-3))	-0.440373	0.156561	-2.812790	0.0138
D(PP_POS)	-0.627162	0.295453	-2.122713	0.0521
D(PP_POS(-1))	0.601965	0.524229	1.148286	0.2701
D(PP_POS(-2))	1.275309	0.579010	2.202568	0.0449
D(PP_POS(-3))	0.481792	0.322964	1.491782	0.1579
D(PP_NEG)	-1.060357	0.618667	-1.713938	0.1086
D(PP_NEG(-1))	1.471521	0.733213	2.006948	0.0645
CointEq(-1)*	-0.100160	0.019838	5.048854	0.0002
R-squared	0.781598		Mean dependent var	4982.306
Adjusted R-squared	0.597681		S.D. dependent var	53973.06
S.E. of regression	34234.39		Akaike info criterion	24.02521
Sum squared resid	2.23E+10		Schwarz criterion	24.77299
Log-likelihood	-415.4538		Hannan-Quinn criterion	24.28621
Durbin-Watson stat	1.877375			

*Source: author's computation, 2024

Analysis of ARDL diagnostic tests

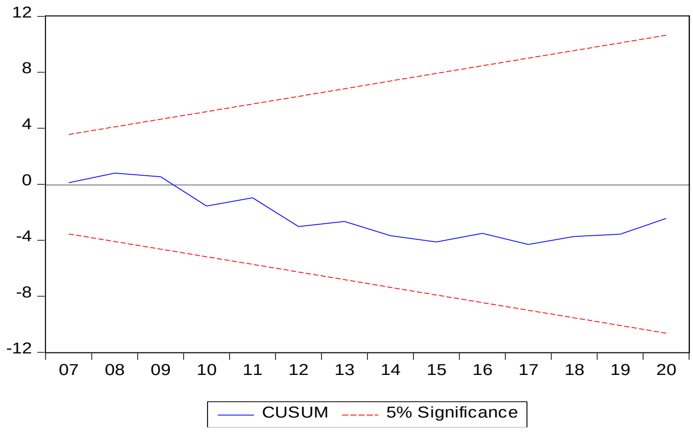
The adequacy of the model's dynamic specifications was assessed through diagnostic tests, including the Jarque–Bera normality test, Breusch–Godfrey autocorrelation diagnostics, Breusch–Pagan–Godfrey tests for heteroscedasticity, and CUSUM and Cumulative Sum of Squares of Recursive Residuals (CUSUMQ) plots to test parameter and variance stability. The results of these diagnostic tests are presented in *Table 9* and *Fig. 7*.

According to the Breusch-Godfrey Serial Correlation LM test and Breusch-Pagan-Godfrey heteroskedasticity test results in *Table 9*, the probability values are greater than 0.05 significance levels, indicating that the null hypotheses of no serial correlation and homoscedasticity cannot be rejected (i.e., the null hypotheses are accepted). This suggests that the model does not exhibit serial correlation issues and maintains equal variance (homoscedasticity). Additionally, the Jarque-Bera normality test yielded a probability value greater than 0.05which is evidence of normality, meaning the series are normally distributed. The CUSUM (blue) line lies within the 5% significance level boundary (i.e., in between the two critical boundary lines). This is evidence of parameter and variance stability

Table 9. Results of diagnostic tests.

Test	$\chi 2$ Statistic	Probability
Serial correlation test	0.4437	0.6579
Heteroskedasticity test	0.7414	0.7396
Jarque-bera test (normality)	3.0746	0.2149

*Source: author's computation, 2024



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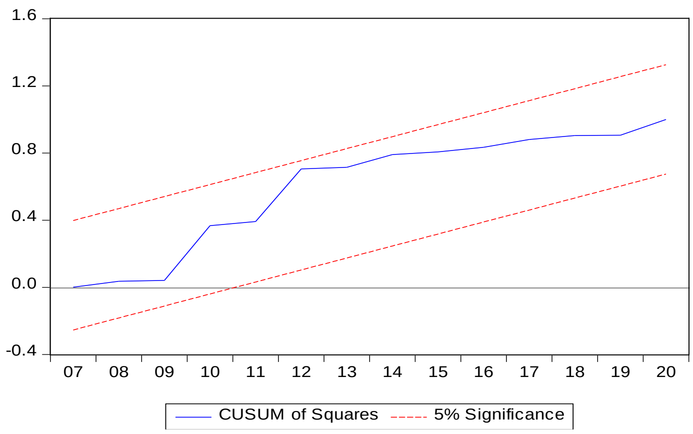


b.

Fig. 7. A plot of the CUSUM and Cumulative Sum of Recursive Residuals of Square (CUSUMq) tests for the ARDL model (source: author's computation 2024).

5.3 | Effects of Fluctuations in Prices on CEX

ARDL bounds testing results

As indicated in *Table 10*, the calculated statistic value is 7.39, exceeding both the lower bound critical value of 2.56 and the upper bound critical value of 3.49 at a 5 per cent significance level. Consequently, the null hypothesis of no cointegration was rejected, suggesting a long-run equilibrium relationship between the dependent variable (CEX quantity) and the independent variables (PP and WP) in the NARDL model.

Table 10. Results of f-bound test.

Critical Value	Lower Bound I(0)	Upper Bound I(0)
1%	3.29	4.37
5%	2.56	3.49
10%	2.20	3.09

*The computed F-statistics = F_{LCEX}(LPP ,LWP) = 7.39
Source: author's computation, 2024

Analysis of the long-run estimates

As shown in *Table 11*, the long-run results of the 2 independent variables are splitted between the positive and negative effects. Both positive and negative effect of WP has significant effects on CEX. The same goes for PP based on their significant probability value. The model suggests that a percent increase in WP increases CEX by 0.688123 while a percent decrease also causes an increase in export but with a lower value of 0.415819. The partial sums of WP both go in the same direction with positive coefficients; similarly, the partial sums of PP also move in the same direction but with negative coefficients.

Table 11. Long-run form of the NARDL.

Variable	Coefficient	Std. Error	T-Statistic	Prob.
WP_POS	0.688123	0.236649	2.907773	0.0075
WP_NEG	0.415819	0.236598	1.757492	0.0911
PP_POS	-0.663881	0.238478	-2.783828	0.0101
PP_NEG	-1.984307	0.676001	-2.935361	0.0070
C	109364.2	13358.16	8.187066	0.0000

*EC = CEX - (0.6881*WP_POS + 0.4158*WP_NEG -0.6639*PP_POS -1.9843*PP_NEG + 109364.1730)
Source: author's computation, 2024

Analysis of the NARDL short-run estimates

The NARDL estimates in *Table 12* explain interactions between CEX and two other independent variables: PP and WP in the short run. The one-period lag error correction term is statistically significant at 5%; it is negative and less than 1, thus satisfying the three criteria. Multiplied by 100, it gives us 78.8%. This is a high speed of adjustment and implies that if there is any disequilibrium in the system, it takes an average speed of 78.8% for the nonlinear ARDL to adjust from the short run back to the long run.

Table 12. Short-run estimates of the NARDL.

Variable	Coefficient	Std. Error	T-Statistic	Prob.
D(WP_POS)	0.134847	0.077549	1.738864	0.0944
D(PP_NEG)	0.276468	0.246769	1.120349	0.2732
D(PP_NEG(-1))	1.377542	0.322136	4.276271	0.0002
D(PP_NEG(-2))	1.631677	0.313175	5.210113	0.0000
D(PP_NEG(-3))	2.028009	0.310470	6.532065	0.0000
CointEq(-1)*	-0.788010	0.107992	-7.296929	0.0000

*Source: author's computation, 2024

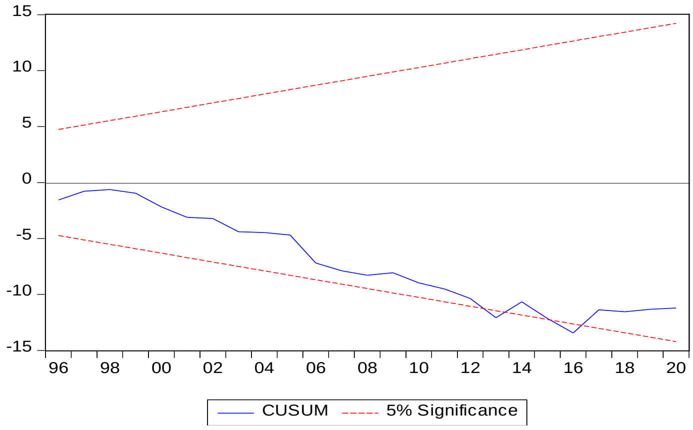
Analysis of the ARDL diagnostic test

Based on the results presented in *Table 13* and *Fig. 8*, the diagnostic tests evaluated the adequacy of the dynamic model specifications. The Breusch-Godfrey Serial Correlation LM test and the Breusch-Pagan-Godfrey tests for heteroskedasticity both yielded probability values greater than 0.05, indicating that the null hypotheses of no serial correlation and homoskedasticity cannot be rejected. Therefore, the model shows no serial correlation issues and exhibits equal variance (homoscedasticity). Additionally, the Jarque-Bera normality test resulted in a probability value greater than 0.05, suggesting that the residuals are normally distributed, which is evidence of normality, meaning the series is normally distributed. However, the CUSUM (blue) line lies outside the 5% significance level boundary (i.e. outside the two critical boundary lines). This indicated some level of parameter instability but the blue line perfectly lies within the boundaries in the CUSUMSQ graph.

Table 13. Results of diagnostic tests.

Test	χ2 Statistic	Probability
Serial Correlation Test	0.7266	0.4943
Heteroskedasticity Test	0.5106	0.8665
Jarque-Bera Test(Normality)	0.5162	0.7725

*Source: author's computation, 2023



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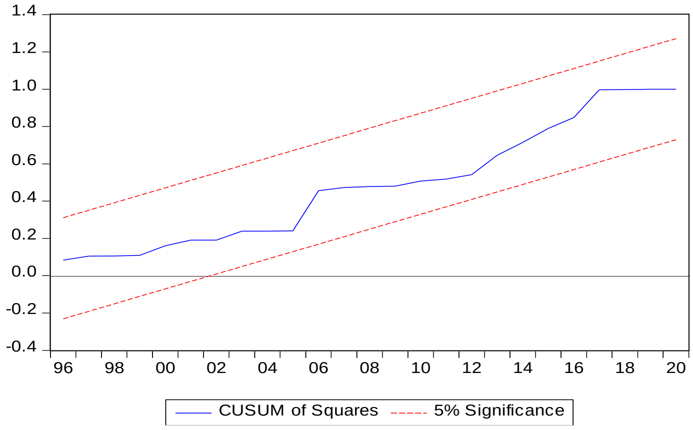

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Fig. 8. Plot of the CUSUM and Cumulative Sum of Recursive Residuals of Square (CUSUMq) tests for ARDL model (source: author's computation, 2024).

6 | Conclusion

The study focused on analyzing the impact of prices on cocoa production and export in Nigeria. The variables under scrutiny included key aspects of cocoa production such as CO/production quantity (CO), YE, AH, and export (CEX), along with cocoa WP and PP. Secondary data sources were employed, primarily drawn from various national and international sources including the FAO publications from the Central Bank of Nigeria (CBN) across different issues, NCB Cocoa Statistics from various releases, and World Bank Commodity price data (the pink sheet), spanning the period from 1980 to 2020. The analytical tools used were descriptive statistics (mean, standard deviation, frequency distribution and percentage), growth function model & graphs and a NARDL model. The result of the growth function analysis indicated a slow growth rate of 0.3%, 2.2%, 1.92% and 2.3% in YE, CO, AH and CEX while WP and PP have a faster growth rate of 18.76% and 13.99% respectively. The result also confirmed significant acceleration in WP, PP, CO, AH,and CEX while for YE, there is stagnancy. The effects of WP and PP on cocoa production and export in Nigeria were also examined adopting a nonlinear ARDL model for the analysis to capture both long-run and short-run asymmetric relations among the variables. From the result, it was found out that both positive and negative effect of PP and WP have insignificant effects on CO while they have significant effects on CEX. Based on the result of the growth function analysis which shows that there is a slow growth rate in cocoa yield, CO, AH and CEX over the period reviewed while WP and PPs experienced faster growth rate. This suggests cocoa farmers could have taken a better advantage of the growing world and PPs if they had improved their level of production and export over the years. Drawing inference from the trend, there are higher chances the WPs and PPs would continue to grow. In view of this, it is recommended that cocoa farmers should step up their game to achieve increased production and export so as to benefit more from the upward trend of the cocoa price. In achieving this, there is a need for farmers to embrace good agricultural practices, plant disease-resistant seeds to reduce crop losses, cultivate more expanse of land, properly ferment their cocoa beans to achieve better production and gain acceptance in the world market etc. The government of the nation should also give more support to the cocoa sector to restore its lost glory by initiating programmes and policies geared towards boosting cocoa production and export.

Author Contribution

The Conceptualization, Olaniyi Damilola Oginni.; Methodology, Olaniran Anthony Thompson and Joseph Olumide Oseni.; Software, Olaniyi Damilola Oginni.; Validation, Olaniran Anthony Thompson., Joseph Olumide Oseni.; visualization, Olaniyi Damilola Oginni. All authors have read and agreed to the published version of the manuscript. All Authors have made a significant contribution to the work reported.

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Data Availability

Some data were obtained from literature, which has been included in the references. No special permission was required for the obtained and used data.

Conflicts of Interest

The authors declare no conflict of interest. No Funders, other than the authors, played a role in the study's design, in the collection, analysis, or interpretation of the data, in the writing of the manuscript, or in the decision to publish the results.

References

[1] Thomas, K. A., Oladjide, A., & Olutayo, M. O. (2022). *Cocoa commercialisation in Nigeria: issues and prospects* (Vol. 79). https://pdfs.semanticscholar.org/99b5/1681b6bfda6a96e0d62364f82167f71a0946.pdf

[2] Oduwole, O. O. (2004). *Adoption of improved agronomic practices by cocoa farmers in Nigeria: a multivariate tobit analysis*. https://www.amazon.com/Adoption-Agronomic-Practices-Farmers-Nigeria/dp/3844313206

[3] Nkang, N. M., Ajah, E. A., Abang, S. O., & Edet, E. O. (2009). Investment in cocoa production in Nigeria: A cost and return analysis of three cocoa production management systems in the Cross River State cocoa belt. *African journal of food, agriculture, nutrition and development*, *9*(2), 713–727.

[4] Afolayan, O. S. (2020). Cocoa production pattern in Nigeria: The missing link in regional agro-economic development. *Annals of the university of oradea, geography series*, *30*(1), 88–96. DOI:10.30892/auog.301110-815

[5] OECD. (2024). *Crop production*. https://doi.org/10.1787/4994e677-en

[6] Sangita, D., & Flavia, N. (2016). *Collecting producer prices at point of sales: rationale, challenges and proposed solutions, the Uganda experience*. https://www.fao.org/fileadmin/templates/ess/documents/apcas26/presentations/APCAS-16-8.6____-_FAO_-_Collecting_Producer_Prices.pdf

[7] Farlex Financial Dictionary. (2009). *World price definition.* https://financial-dictionary-the-freedictionary.com/World+Price.

[8] Mchopa, A., Kazungu, I., & Ndiege, B. (2012). *Pricing issues and perspective*. Internal Printers Ltd. Moshi.

[9] Mishra, A. K., & Regmi, U. (2017). Effects of price fluctuation on the financial capacity of "Class A" contractors. *International journal of creative research thoughts (ijcrt)*, *5*(4), 1920–1938.

[10] AArısoy, H., & Bayramoğlu, Z. (2017). Determination of the effect of price fluctuations on producer income--the case of potatoes. *Turkish journal of agriculture-food science and technology*, *5*(11), 1342–1349.

[11] Ebi, B., & Ape, A. S. (2014). *Supply response of selected agricultural export commodities in Nigeria*. Lap Lambert Academic Publishing.

[12] Mesike, C. S., Okoh, R. N., & OE, I. (2011). Cocoa supply response in Nigeria: an error correction modelling approach. *International journal of agricultural and rural development*, *3*(1), 2–6.

[13] Darkwah, S. A., & Verter, N. (2014). An empirical analysis of cocoa bean production in Ghana. *European scientific journal*, *10*(16), 295–306.

[14] Gama, E. N., Abdusalam, R. Y., & Katanga, Y. N. (2021). Estimation of short-run and long-run effects of cocoa price fluctuation on export and area harvested in Nigeria. *Dutse journal of pure and applied sciences (dujopas)*, *7*(1), 110–115.

[15] Essien, E. B., Dominic, A. O., & Sunday, E. R. (2011). Effects of price and exchange rate Fluctuations on agricultural exports in Nigeria. *International journal of economic development research and investment*, *2*(1), 1–10.

[16] Xie HuaLin, X. H., & Wang BoHao, W. B. (2017). *An empirical analysis of the impact of agricultural product price fluctuations on China's grain yield.* http://www.mdpi.com/2071-1050/9/6/906/htm

[17] Ogunleye, K. Y., & Oladeji, J. O. (2007). Choice of cocoa market channels among cocoa farmers in ila local government area of Osun state, Nigeria. *Middle-east journal of scientific research*, *2*(1), 14–20.

[18] Agbebaku, E. E. O., Akinlembola, O. A., Folarin, O. E., Dada, O. A., & Orisasona, T. M. (2017). Perceived effects of cocoa price variation on cocoa marketing in Nigeria. *International journal of innovative research and advanced studies(ijiras)*, *4*(3), 415–421.

[19] Awoyemi, A. O., & Aderinoye-Abdulwahab, S. A. (2019). Assessment of the use of cocoa production management practices among cocoa farmers in Ekiti State, Nigeria. *Agro-science*, *18*(2), 37–41. https://doi.org/10.4314/as.v18i2.7

[20] Huka, H., Ruoja, C., & Mchopa, A. (2014). Price fluctuation of agricultural products and its impact on small scale farmers development: Case analysis from Kilimanjaro Tanzania. *European journal of business and management*, *6*(36), 155–160.

[21] Thornton, P. K., Jones, P. G., Alagarswamy, G., Andresen, J., & Herrero, M. (2010). Adapting to climate change: agricultural system and household impacts in East Africa. *Agricultural systems*, *103*(2), 73–82. https://doi.org/10.1016/j.agsy.2009.09.003

[22] Timmer, P. (2011). *Managing Price Volatility: Approaches at the global, national, and household levels*. Center on Food Security and the Environment.

[23] Triki, T., & Affes, Y. (2011). Managing commodity price volatility in Africa. *Africa economic brief*, *2*(12), 1–7.

[24] Mustapha, U., & Culas, R. (2013). Causes, magnitude and consequences of price variability in agricultural commodity market: an african perspective. *Australian conference of economists* (pp. 1–26). The Economic Society of Australia.

[25] Cheah, S.-P., Yiew, T.-H., & Ng, C.-F. (2017). A nonlinear ARDL analysis on the relation between stock price and exchange rate in Malaysia. *Economics bulletin*, *37*(1), 336–346.

[26] Pal, D., & Mitra, S. K. (2016). Asymmetric oil product pricing in India: Evidence from a multiple threshold nonlinear ARDL model. *Economic modelling*, *59*, 314–328. https://doi.org/10.1016/j.econmod.2016.08.003

[27] Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in honor of peter schmidt: econometric methods and applications* (pp. 281–314). Springer.

[28] Nkoro, E., Uko, A. K., & others. (2016). Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation. *Journal of statistical and econometric methods*, *5*(4), 63–91.

[29] Wikipedia. (2023). *Internet geography*. https://en.m.wikipedia.org/wiki/Geography_of_Nigeria

[30] Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289–326. https://doi.org/10.1002/jae.616

[31] Pesaran, H. H., & Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. *Economics letters*, *58*(1), 17–29. https://doi.org/10.1016/S0165-1765(97)00214-0

[32] Olufikayo, O. (2019). *Investors miss opportunities in cocoa value chain.* https://businessday.ng/wealth-and-inves_ng/ar_cle/investors-miss-opportuni_es-incocoa-value-chain/

[33] Idowu, E. O., Osuntogun, D. A., & Oluwasola, O. (2007). Effects of market deregulation on cocoa (Theobroma cacao) production in Southwest Nigeria. *African journal of agricultural research*, *2*(9), 429–434.

[34] Bello, T., & Mitchell, M. I. (2018). The political economy of cocoa in Nigeria: A history of conflict or cooperation? *Africa today*, *64*(3), 71–91. https://www.jstor.org/stable/10.2979/africatoday.64.3.04%0A

[35] Kolesnik, K. (2017). *Structural Adjustment programme in Nigeria: causes, processes and outcomes.* https://www.legit.ng/1119733-structural-adjustment-programme-nigeriaprocesses-outcomes.html

[36] Ajiola, O. (2018). *Accumulation and dispossession: cocoa production, rural development and the structural adjustment programme in southwest Nigeria, 1986 – 1996.* https://www.ajol.info/index.php/lhr/ar_cle/view/200812

[37] Meludu, N. T., Babalola, E., Okanlawon, O. M., & Olanrewaju, P. O. (2017). Perceived effect of agricultural transformation agenda on livelihood of cocoa farmers in Osun State, Nigeria. *Journal of agricultural extension*, *21*(2), 17–29.

[38] Verter, N., & Bečvářová, V. (2014). Analysis of some drivers of cocoa export in Nigeria in the era of trade liberalization. *Agris on-line papers in economics and informatics*, *6*(4), 208–218. http://dx.doi.org/10.22004/ag.econ.196590

[39] Nwachukwu, I. N., Agwu, N., Nwaru, J., & Imonikhe, G. (2010). Competitiveness and determinants of cocoa export from Nigeria. *Report and opinion*, *2*(7), 51–54.