

Impact of Exchange Rate on Export of Cocoa in Nigeria

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ABSTRACT

This study examined the impact of the exchange rate on cocoa exports in Nigeria from 1986 to 2023, within a macroeconomic environment featuring gross domestic product (GDP) and inflation rate. Utilizing Autoregressive Distributed Lag (ARDL) and Kernel-based Regularized Least Squares (KRLS) methods, the study analyzed cocoa export volume, the official nominal exchange rate, GDP, and inflation. Empirical findings reveal that a 1% depreciation of the Naira against the US Dollar enhances Nigeria's long-run and short-run cocoa export growth by 0.21% and 0.18%, respectively, indicating that cross-border trade benefits from a weaker national currency. Also 1% increase in real GDP contributes 0.42% to long-run cocoa export growth, demonstrating that economic expansion drives export development, 1% increase in the inflation rate lowers long-run cocoa export growth by 0.0034%, showing that inflation inhibits trade. The study concludes that Nigerian cocoa exports thrive under moderate exchange rate increases combined with rising GDP and low inflation. Federal Government should stabilize forex access at the official rate by prioritizing cocoa exporters in foreign exchange allocations to reduce input costs, and producers must leverage national economic growth by investing in modern farming techniques, such as high-yield seedlings and precision agriculture to boost productivity. Government should establish dedicated agricultural credit facilities with low-interest loans and financial literacy programs to enhance farmers' resilience against inflationary shocks.

Keywords: Exchange Rate, Cocoa Export, GDP, Inflation, ARDL, Kernel-based regularized least squares.

1. INTRODUCTION

Nigeria has long been recognized as one of the world's leading producers and exporters of cocoa, a commodity that has historically played a pivotal role in the nation's economic development and foreign exchange earnings. Cocoa exports remain a vital source of revenue, job creation, and rural livelihoods, particularly in the south western region of the country where cultivation is heavily concentrated. Despite its significance, the performance of Nigeria's cocoa export sector has been subject to various macroeconomic challenges, among which exchange rate instability, domestic economic shifts, and monetary pressures such as inflation are prominent.

Historically, Nigeria was a dominant global cocoa producer during the 1960s and 1970s, with production levels reaching approximately 280,000 metric tons and 300,000 metric tons, respectively. However, the sector's decline began in the 1980s, driven by a combination of policy failures, structural neglect, and the 1970s oil boom, which diverted government attention and investment away from agriculture. This period saw the centralization of the Commodity Marketing Board, which soon faced deep systemic inefficiencies, adversely affecting price structures and market stability for local farmers (CBN, 2024).

The liberalization policies initiated in 1986, particularly the adoption of the Structural Adjustment Programme (SAP), revolutionized the agricultural export landscape (Okonjo-Iweala & Ojo, 2020). The dismantling of government-controlled commodity boards, including the Nigerian Cocoa Board, aimed to make the sector more market-oriented and globally competitive. While this deregulation allowed producer prices to reflect market realities, it simultaneously exposed cocoa farmers to external shocks such as rapid exchange rate depreciation and rising inflation without adequate institutional safety nets.

Although SAP eliminated marketing boards and created short-term price incentives that triggered a temporary export boom between 1987 and 1989, structural bottlenecks persisted. Throughout the 1990s and 2000s, cocoa exports fluctuated wildly in response to volatile exchange rate movements, shifting global demand, and inconsistent domestic agricultural frameworks (Olaniyi et al., 2024).

Exchange rate instability plays a dual role in shaping export performance. Theoretically, the depreciation of the Naira against major currencies like the US dollar increases the local currency value of exports, boosting farmers' returns and export earnings. Conversely, excessive volatility introduces severe market risks, deterring long-term investments in production and logistics. This volatility, coupled with macroeconomic instability and fluctuating oil revenues since 1986, closely mirrors the non-cyclical, unstable pattern of Nigerian cocoa exports over the past few decades.

Gross Domestic Product (GDP) and domestic inflation further complicate this landscape. GDP growth reflects the underlying domestic economic conditions that dictate production capacity, infrastructure development, and supply-chain efficiency. Enhanced economic output often improves government capacity to fund agricultural support initiatives, such as the National Cocoa Rehabilitation Programme, of 1999 (Vestanceng, 2025). On the other hand, inflation erodes the real incomes of producers and spikes the cost of vital inputs like machinery, chemical fertilizers, and transport, suppressing global competitiveness (Nwosu & Onwuka, 2022).

Because empirical studies regarding the exact magnitude and nature of exchange rate risks on agricultural exports remain largely inconclusive, a significant analytical gap persists. This study directly addresses these conflicts by evaluating the combined interactions of the exchange rate, GDP, and inflation on Nigerian cocoa export volumes over a 37-year period from 1986 through 2023.

Nigeria's cocoa export sector has experienced prolonged decline and volatility since its peak in the mid-20th century. A foundational disruption occurred with the 1986 dissolution of the Nigerian Cocoa Board under SAP, leaving fragmented local producers exposed to severe international price shocks and domestic currency risks without policy padding. The scale of exchange rate volatility is stark: the official nominal exchange rate degenerated from approximately ₦0.6 per US dollar in 1986 to over ₦400 per US dollar by 2023, embedding severe transaction uncertainty for exporters (Babatunde, Eze & Amadi, 2024).

This currency depreciation has occurred alongside intense domestic inflationary pressures, with inflation rates averaging over 18% in the early 2020s (Adegboye, Okinlabi, & Olawale, 2024).

High inflation drastically inflates production costs, diminishes profit margins, and compresses real farm yields. Consequently, rather than expanding sustainably, Nigerian annual cocoa exports have stagnated between 100,000 and 150,000 metric tons over the past two decades far below historical baselines.

While contemporary literature acknowledges these challenges, a major empirical gap remains. Existing studies often treat these macroeconomic variables in isolation or lean on purely descriptive frameworks that fail to quantify their simultaneous, multi-variate impacts over a prolonged timeline (Eze & Chukwuemeka, 2025). Policymakers are left without robust, longitudinal evidence showing how the historic depreciation of the Naira interacts with shifting real GDP growth and inflationary trends to alter export behaviour.

Compounding these structural issues is a low standard of living among smallholder farmers, which restricts access to technical education, healthcare, and modern agricultural technology. This socioeconomic vulnerability discourages younger demographics from entering agribusiness, causing an aging farming population and low innovation. To establish effective intervention strategies, this study comprehensively models these shifting dynamics from 1986 to 2023.

Thus, the objective of this study is to examine the impact of exchange rate on export of cocoa in Nigeria taking the macroeconomic environment into consideration. Consequently, the specific objectives include to:

1. Examine the extent to which exchange rate affects total cocoa exports in Nigeria.
2. Evaluate the effect of Nigeria's Gross Domestic Product (GDP) on Cocoa export in Nigeria.
3. Ascertain the extent to which inflation affect exports of cocoa in Nigeria.

2. Literature Review

2.1 Conceptual Review

2.1.1 Exchange rate

An exchange rate is defined as the price of one currency expressed in terms of another currency, reflecting how much of one currency can be exchanged for a unit of another, It functions as a vital macroeconomic indicator that influences a country's international competitiveness and serves as a nominal anchor for domestic price stability. Exchange rates are typically quoted using two conventions: the direct method, which expresses the price of the home currency per unit of foreign currency (e.g., N305 = 0.003). Nigeria employs the direct method in which the exchange rate appreciates when fewer naira are needed to buy one unit of foreign currency and depreciates otherwise.

Exchange rates operate under different regimes, with two primary extremes: fixed and floating. A fixed exchange rate system involves government or central bank control, where the rate is maintained by administrative fiat, often requiring large foreign reserves (Central Bank of Nigeria, 2022) Exchange Rate Management in Nigeria. Variants include adjustable pegs and crawling pegs. Conversely, a floating or flexible exchange rate system is determined by supply and demand forces in the foreign exchange market without direct intervention (Central Bank of Nigeria, 2022). In practice, many countries, including Nigeria, adopt managed or hybrid regimes that blend elements of both systems.

Monetary policy influences exchange rate, instead of fiscal policy. Reason being that Monetary policy has a direct influence on exchange rate, while fiscal policy has a secondary influence on exchange rate. As a price that balances supply and demand for foreign currency, the exchange rate is a key determinant of trade competitiveness since it affects the relative cost of imports and exports. Currency depreciation can enhance export competitiveness by making exports cheaper for foreign buyers, while appreciation may have the opposite effect. However, excessive volatility can deter investment and disrupt trade flows.

Furthermore, the concept of the real exchange rate extends this by incorporating relative price levels between countries, thus reflecting the purchasing power of a currency in terms of goods and services. The real exchange rate adjusts the nominal exchange rate to account for inflation differentials, providing a more accurate measure of a country's trade competitiveness over time.

2.1.2 Inflation

Inflation is broadly understood as the sustained increase in the general price level of goods and services in an economy over time, leading to a decline in the purchasing power of money. Conceptually, inflation can be modelled as a mark-up of prices over total unit costs, which include labour costs, import prices, and energy prices. This mark-up model suggests that the domestic price level is determined by the costs of production plus a profit margin, and these costs are influenced by factors such as wages, tariffs, and commodity prices (e.g., petrol). The concept of inflation is based on the following key points

Cost-Push Factors: Rising input costs, such as wages and import prices, increase production costs, which are passed on to consumers as higher prices. For example, increases in unit of labour costs or energy prices directly contribute to inflationary pressures.

Demand-Pull Factors: When aggregate demand in the economy exceeds supply capacity, prices rise as consumers compete for limited goods and services. This is often linked to increases in money supply or credit availability.

External Influences: Import prices and exchange rates affect domestic inflation by altering the cost of imported goods and services. A depreciation of the domestic currency can increase import prices, contributing to inflation.

2.1.3 Gross Domestic Product (GDP)

Gross Domestic Product (GDP) is a comprehensive measure of a country's economic activity, representing the total monetary value of all finished goods and services produced within a nation's borders over a specific period, typically annually or quarterly. It serves as a key indicator of economic health and growth, providing policymakers, investors, and businesses with insights into the size and performance of an economy. The conceptual framework of GDP is built around three primary approaches to measurement:

Production (Output) Approach: This approach calculates GDP by summing the value added at each stage of production across all sectors of the economy. It involves estimating the gross value of domestic output and subtracting intermediate consumption (the cost of materials and services used in production) to arrive at the gross value added (GVA). Adding taxes less subsidies on products to GVA yields GDP at producer prices.

Expenditure Approach: GDP is calculated as the total spending on final goods and services within the economy. The formula is:

$$\text{GDP} = C + I + G + (X-M) \quad 1$$

Where C is private consumption, I is investment, G is government spending, and (X-M) is net exports (exports minus imports). This approach reflects the demand side of the economy and highlights the role of consumer confidence, business investment, and government expenditure in driving economic growth.

Income Approach: This method sums all incomes earned by factors of production, including wages, rents, interest, and profits. Adding taxes less subsidies on production and imports to total factor income gives GDP at purchaser prices. It reflects the distribution of income generated by economic activity.

The conceptual Review also recognizes that GDP can be measured in nominal terms (current prices) or real terms (adjusted for inflation). Real GDP provides a more accurate reflection of economic growth by removing the effects of price changes over time.

GDP is influenced by various factors including consumption patterns, investment levels, government policies, trade balances, and external economic conditions. It is often used to compare economic performance across countries and over time, although it has limitations such as not accounting for environmental degradation or informal economic activities.

In summary, the conceptual framework of GDP integrates production, expenditure, and income perspectives to provide a holistic measure of economic activity, serving as a vital tool for economic analysis and policy formulation.

2.2 Theoretical Review

The theoretical framework of this study anchors on Cobb-Douglas production function and Solow swan theory of economic growth. The Cobb-Douglas production function provides a theoretical framework to analyse the relationship between exchange rate fluctuations and cocoa exports in Nigeria. This model is particularly useful for understanding how key inputs (e.g., labour, capital, and exchange rate) interact to influence cocoa export performance. The Cobb-Douglas production function is expressed as:

$$Y = A \times E^{\alpha} \times X^{\beta} \quad Y=A \times E^{\alpha} \times X^{\beta} \quad 2$$

where:

Y represents the cocoa export output,

E represents the exchange rate (which affects the cost and profitability of exports),

X represents other relevant inputs or factors affecting cocoa export such as labour, land, or capital used in cocoa production,

A is total factor productivity capturing technology or efficiency,

α and β are the output elasticities of exchange rate and other inputs, respectively.

This model theoretically explains how changes in the exchange rate can influence cocoa export volumes in Nigeria by affecting export competitiveness and production incentives. Devaluation of the naira (exchange rate change) can directly stimulate cocoa export by making Nigerian cocoa cheaper in foreign markets, thus potentially increasing export quantity and foreign exchange earnings for Nigeria. The function can incorporate additional factors to reflect complex production and export decisions.

2.3 Empirical review

The exchange rate dynamics and cocoa export relationship has been studied in various climes with empirical evidence highlighting both direct and indirect effects. This section synthesizes key findings from prior research, focusing on methodologies, variables, and outcomes. Multiple studies have established that exchange rate fluctuations significantly affect cocoa export performance in Nigeria. For instance, Abubakar et al. (2025) employed an Auto Regressive Distributed Lag (ARDL) model on data spanning 1981 to 2017, finding that exchange rate depreciation, broad money supply, and lagged inflation rates meaningfully influence Nigeria's inflation. They underscore a long-run relationship where inflation is significantly affected by external variables like exchange rates, with inflation creating uncertainty that suppresses export competitiveness.

Alori and Kutu (2019) employed Structural Vector Autoregressive (SVAR) and Ordinary Least Squares (OLS) models to analyse monthly data from 1970 to 2016. They found that exchange rate volatility negatively impacts cocoa export growth, with shocks to exchange rates accounting for the majority (60–70%) of variations in export values. A 10% increase in exchange rate reduced cocoa export volumes by 5–7%, underscoring the destabilizing effect of currency instability on trade. Similarly, Ene et al. (2023) used Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models to analyse data from 1980 to 2016 and confirmed that exchange rate volatility had a significant negative impact on cocoa, rubber, and cashew exports. Their Granger causality tests revealed unidirectional causality from exchange rate volatility to cocoa export performance, suggesting that currency instability is a primary driver of export declines.

Likewise, Udo and Nsikak (2020) examined the effect of exchange rate instability on Nigeria's agricultural export performance using annual data from 1980-2015. The Generalized Autoregressive Conditional Heteroscedasticity (GARCH1,1) model was used to generate the exchange rate volatility series which was subsequently incorporated into the Autoregressive Distributed Lag (ARDL) Model for determining factors affecting agricultural exports (cocoa and rubber). The Bounds Test revealed long-run relationship among variables. The results indicated that exchange rate volatility did not significantly affect exports both in the short-run and the long-run. This may be partially attributed to the inelastic nature of agricultural commodities' supply particularly in the short run. It was also revealed that there was a positive and significant relationship between exchange rate, inflation, GDP, domestic prices, world prices and agricultural export.

Nkwi, Ahungwa, and Folorunso (2021) conducted an econometric analysis of cocoa production in Nigeria spanning the period 1970 to 2018. Their study utilized time series data and employed unit root tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) procedures to examine stationarity and cointegration relationships among key variables influencing cocoa

output. The findings revealed that cocoa production is significantly influenced by factors such as area harvested by farmers and cost inputs, with an indication of improvements in production due to sustained increases in cultivated land. The study highlighted the policy implications, recommending government intervention to adopt favourable export policies and enhance the cocoa value chain to boost foreign exchange earnings and contribute positively to Nigeria's GDP.

Manasseh, Logan, Okanya, Nduka, Ede, Okeke, Lawal, and John (2020) investigates the effect of exchange rate volatility on exports in selected G7, Asian, and West African countries, utilizing data from 1996 to 2018. The ARDL result showed a significant negative impact of exchange rate volatility a (2022) examined the factors influencing the domestic supply of cocoa in Nigeria. Time series data covering the period between 1980 and 2017. The results of error correction analysis revealed that the domestic supply of cocoa is negatively influenced by interest rate, inflation rate, and producer price of cocoa.

Several studies rely primarily on traditional econometric techniques such as co-integration, error correction models, and ordinary least squares applied to aggregated national time-series data (Uduh, 2017; Okoh, 2019). These methods provide broad insights but often fail to capture dynamic and nonlinear relationships, such as asymmetric impacts of exchange rate fluctuations or the effects of sudden macroeconomic shocks. Advanced econometric models like Structural Vector Autoregressive (SVAR) or GARCH models, while emerging, are still underutilized. Incorporating higher-frequency or disaggregated data could better capture short-run and long-run change using Auto regressive Distributed Lag method (ARDL) and the Kernel-base Regularized least square method (KRLS). Most existing research treats Nigeria as a homogeneous unit, averaging data over years and regions. Considering that cocoa production is concentrated in specific regions with varied exposure to exchange rate and infrastructural issues, there remains a gap in regional and micro-level studies. Also, sector-specific influencers, such as farm-level production costs versus export-level market conditions, are not deeply explored, limiting detailed policy prescriptions for cocoa exporters.

Interaction with other macroeconomic variables: the literature often isolates exchange rate as the key determinant of cocoa exports without fully modelling its interactions with related factors like inflation and gross domestic product. These variables collectively shape cocoa export performance but are rarely integrated simultaneously into empirical models, leading to an incomplete understanding of export dynamics. Additionally, previous studies (e.g., Gatawa & Mahmud, 2017; Ogunkoya & Shobayo, 2015; Udo & Nsikak, 2022) tend to focus on isolated determinants or employ commodity-specific gravity models that primarily emphasize GDP and exchange rate policy, often neglecting the simultaneous impact of monetary factors like real GDP and inflation. Though the studies identified major factors influencing cocoa exports, such as GDP, exchange rate policy, trade agreements, and infrastructure, there is a notable scarcity of research that comprehensively examines the combined effects of key macroeconomic variables, particularly GDP and inflation in the study of the Impact of exchange rate on cocoa export volume in Nigeria, which makes the present Study Imperative.

3. Methodology

The study uses a quantitative research design, leveraging econometric techniques to analyse secondary data. The choice of this design is informed by its ability to quantify relationships between variables and provide empirical evidence for policy recommendations, as those techniques employed allows for the examination of time-series dimensions of cocoa export flows.

To rigorously analyse the impact of exchange rate, GDP and inflation on cocoa exports, we resorted to a dynamic regression model which integrates both the mean and variance dynamics is required. The Autoregressive Conditional Heteroskedasticity (ARCH) model is well-suited for this purpose, as it models time-varying volatility in economic time series and allows for the assessment of how fluctuations in macroeconomic variables influence export performance.

The ARCH model is structured in two main components: the mean equation and the variance (volatility) equation. The mean equation models cocoa exports as a function of the exchange rate, GDP and inflation, typically in a log-linear form to facilitate elasticity interpretation. The variance equation models the conditional volatility of cocoa exports, which is influenced by past shocks, and its own past volatility, as well as the volatility of the macroeconomic predictors.

The mean equation can be specified as:

$$\ln(\text{COCEXP}_t) = \beta_0 + \beta_1 \ln(\text{EXR}_t) + \beta_2 \ln(\text{GDP}_t) + \beta_3 (\text{INFL}_t) + \varepsilon_t \quad 1$$

Where: $\ln(\text{COCOA}_t)$ is the natural logarithm of total cocoa export volume at time t ,

$\ln(\text{EXCH}_t)$ is the log of the exchange rate,

$\ln(\text{GDP}_t)$ is the log of GDP,

INFL_t is the inflation rate,

ε_t is the error term.

The error term ε_t is assumed to follow a conditional variance process, modelled as:

$$\varepsilon_t \sim N(0, \sigma_t^2) \quad 2$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \quad 3$$

This is the standard ARCH (1,1) specification, where σ_t^2 is the conditional variance of the error term at time t , ε_{t-1}^2 is the lagged squared residual (shock), and σ_{t-1}^2 is the lagged variance. The parameters α_1 and β_1 capture the short- and long-term persistence of volatility, respectively.

This approach allows the model to account for periods of high and low volatility in cocoa exports, which may be driven by instability in the exchange rate, GDP growth and inflation. By incorporating the ARCH process, the model not only estimates the direct effects of macroeconomic variables on cocoa exports but also quantifies how volatility in these variables transmits to export performance. This is particularly relevant for agricultural exports in developing economies, where external shocks and policy changes can generate significant fluctuations in trade outcomes.

Estimation procedure

We employed the regression analysis in this study. First, the time series data were subjected to preliminary tests of stationary using standard unit root tests. Based on the results, the researchers employed the autoregressive distributed lag (ARDL) method to estimate the parameters of the cocoa growth regression model and then used the ARDL Bounds test to investigate the existence of a long-run relationship among the variables of the empirical model of the study. The ARDL form of the empirical model of this study take the form:

$$COCEXP = \beta_0 + \beta_1 \sum_{k=1}^n EXR_k + \beta_2 \sum_{k=1}^n EXR_{k-1} + \beta_3 \sum_{k=1}^n GDP_k + \beta_4 \sum_{k=1}^n GDP_{k-1} + \beta_5 \sum_{k=1}^n INF_k + \beta_6 \sum_{k=1}^n INF_{k-1} + \mu_k \quad 4$$

Thereafter, we employed the Kernel-based regularised least squares (KRLS) method to confirm the ARDL estimates and then the autoregressive conditional heteroskedasticity (ARCH) approach to investigate the issue of volatility of the exchange rate variable. Thereafter, we administered diagnostic tests such as autocorrelation, heteroskedasticity test, normality test, and stability tests to evaluate the robustness of the estimated parameters.

The data for this study were obtained from institutional sources, including, Central Bank of Nigeria (CBN) Statistical Bulletin of 2023, National Bureau of Statistics (NBS) Cocoa production and export statistics, International Cocoa Organization (ICCO) global cocoa price trends, and development indicators published by the World Bank. The data are annual time series for Nigeria spanning the 37-year period of 1986-2023.

4. RESULTS

Preliminary results

The descriptive statistics of the data employed in this study are presented in Table 1 as follows:

Table 1: Descriptive statistics

Statistic	COCEXP	EXR	GDP	INF
Mean	412657895	144.8066	42379.22	19.56418
Median	410000000	127.2424	37218.27	12.94178
Maximum	791000000	645.1941	76684.94	72.83550
Minimum	173000000	2.020575	17007.77	5.388008
Std. Dev.	181947761	143.7022	21107.56	17.11449
Skewness	0.156525	1.462354	0.313370	1.757997
Kurtosis	1.725422	5.295983	1.458731	4.885913
Jarque-Bera	2.727371	21.89029	4.383163	25.20489
Probability	0.255717	0.000018	0.111740	0.000003
Sum	15681000000	5502.652	1610410.	743.4388
Sum Sq. Dev.	1.22E+18	764062.4	1.65E+10	10837.52
Observations	38	38	38	38

Source: Researcher's computation (2025) from EViews 12

The time series data consists of 38 observations for four variables, namely, total cocoa export volume (COCEXP), exchange rate (EXR), gross domestic product (GDP), and inflation rate (INF). The descriptive statistics in Table 1 include the mean, median, maximum, minimum,

standard deviation, skewness, and kurtosis. These describe the location, dispersion, and distribution of the data for each variable. For example, COCEXP averaged 41,2657,895 million tons in volume between 1986 and 2023 though it ranged from 173,000,000 million Naira to 791,000,000million Naira in the process. Likewise, the official exchange rate of Naira to 1 US Dollar averaged 144.81 with the highest value being 645 and the lowest 2.02 in that period. Similarly, GDP averaged 42,379.22 billion Naira annually between 1986 and 2023, and inflation rate averaged 19.6% in the period and ranged from 5.4. to 72.8 in the process. Regarding the distribution, we expect that the data should be normally distributed in which case it lends itself to several statistical analysis. In a normally distributed data, the skewness is about zero, the kurtosis should be less than 3, and the probability of the Jarque-Bera (J-B) statistic should be greater than 0.05 (Adebile& Amusan, 2011). This means that in Table 1, the data for cocoa export (COCEXP) and GDP satisfy these conditions which means that they are normally distributed. On the other hand, the log of exchange rate (EXR) and the first difference of inflation (INF) rate are normally distributed.

Unit root test results

We used the Dickey-Fuller and the Phillips-Perron tests to establish the order of integration of the variables of the study. The summary of each result is presented below.

Table 2: Summary of the Dickey-Fuller unit root test result

Series	Z-test statistic	5% Critical value	P-value	Z-Test statistic	5% Critical value	P-value	Order of Integration
	(Level)			(1 st Difference)			
logCOCEXP	-0.678	-2.966	0.895	-8.332	-2.969	0.000	I(1)
logEXR	-2.336	-2.966	0.161	-6.069	-2.969	0.000	I(1)
logGDP	-0.628	-2.966	0.864	-3.879	-2.969	0.002	I(1)
INF	-2.897	-2.966	0.046	-	-	-	I(0)

Source: Researcher's computation (2025) from STATA 16

The result in Table 2 summarises the results from the Dickey-Fuller unit root test. A dataset has a unit root (non-stationary) if the p-value of its z-statistic is greater than 0.05 It shows that the dependent variable, log of cocoa export (logGDP), is stationary at first difference, same as log of exchange rate (logEXR) and log of GDP (logGDP). On the other hand, inflation rate (INF) is stationary at level. Thus, the variables have a mixed order of integration, namely, zero and one. Furthermore, we applied the Phillips-Perron test to confirm the results.

Table 3: Summary of Phillips-Perron unit root test result

Series	Z-Test statistic	5% Critical value	P-value	Z-Test statistic	5% Critical value	P-value	Order of Integration
	Level			(1 st Difference)			
logCOCEXP	-0.452	-2.966	0.901	-8.264	-2.969	0.000	I(1)
logEXR	-2.461	-2.966	0.125	-6.084	-2.966	0.000	I(1)
logGDP	-0.595	-2.966	0.872	-3.980	-2.969	0.002	I(1)
INF	-2.947	-2.966	0.040	-	-	-	I(0)

Source: Researcher's computation (2025) from STATA 16

The Phillips-Peron result in Table 3 shows that log COCEXP, log EXR, and log GDP are stationary at first difference whereas inflation rate is stationary at level. The result is in agreement with that of the augmented Dickey-Fuller unit root test. We therefore employed the autoregressive distributed lag (ARDL) method to estimate the regression model.

Regression result

Autoregressive distributed lag (ARDL) result

A summary of the linear ARDL result is presented in Table 4.

Table 4: Summary of the linear ARDL result

Dep.var: log cocoa export						
L1.lngdp	Long-run			Short-run		
	Variable	Coef.	P-value	Variable	Coef.	P-value
-0.889***	L1.lexr	0.2053	0.000	D1.lexr	0.183	0.000
	L1.gdp	0.4220	0.001	D1.lgdp	0.505	0.508
	L1.inf	-0.0034	0.051	LD.lgdp	-0.644	0.314
	_cons			D1.inf	-0.003	0.05

Source: Researcher's computation (2025) from STATA 16 (***) means sig. at 0.01 level)

The result shows that the error correction coefficient of the short run model is -0.889 which means that the short-run model adjusts to long-run equilibrium at the speed of 89% per annum which implies a return to long-run equilibrium in about one year and one month following a period of disequilibrium. This is evidence of long-run relationship which will be further examined using the Bounds test.

The result in Table 4 shows that a percentage increase in the exchange rate (lexr) significantly improves long-run growth of cocoa export (lcocexp) by 0.21%. This means that the volume of cocoa export (in tons) increases as the currency depreciates vis-à-vis the US Dollar. In the other results, a percentage increase in economic growth (lgdp) significantly increases the value of cocoa export by 0.42% in the long run, whereas a percentage increase in inflation rate (inf) significantly lowers the value of cocoa export by 0.003% in the long run.

In the short run, however, a percentage increase in the Naira/Dollar exchange rate (₦/1\$) significantly increases cocoa export volume (lcocexp) by 0.18% in the short run. In the other results, GDP growth has no significant effect on the volume of cocoa export in the short run, whereas a percentage increase in inflation rate (inf) significantly lowers the volume of cocoa export by 0.003% in the short run.

Result of the Bounds test of cointegration

The ARDL Bounds test result is presented in Table 5.

Table 5: The ARDL Bounds test result

H0: no level relationship							F =	5.680	
Case 2							t =	-4.451	
Kripfganz and Schneider (2020) critical values and approximate p-values									
	10%		5%		1%		p-value		
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
F	2.606	3.621	3.176	4.338	4.573	6.079	0.003	0.014	
t	-2.539	-3.439	-2.904	-3.857	-3.656	-4.711	0.002	0.017	
Decision: no rejection (.a), inconclusive (.), or rejection (.r) at levels:									
	10%	5%	1%						
decision	.r	.r	.						

Source: Researcher's computation (2025) from STATA 16

In Table 5, the computed F-statistic (5.68) and t-statistic (-4.451) are greater than the 5% upper bound critical values in absolute terms ($F = 4.338$, $t = -3.857$). Also, the upper bound p-values of the F-stat ($p = 0.014$) and T-stat ($p = 0.017$) are each less than 0.05. Consequently, the null hypothesis of no level (long-run) relationship is rejected at the 5% level of significance. This signifies that there is long-run relationship among the variables of the study.

Model diagnostics

The researcher checked the estimated model for autocorrelation using the Breusch-Godfrey LaGrange multiplier (LM) test for autocorrelation and obtained the following result:

Table 6: Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
4	2.5713	1	0.0800
H0: no serial correlation			

Source: Researcher's computation (2025) from STATA 16

The result in Table 6 reveals that the null hypothesis of no serial correlation is accepted at the 5% level. This implies that the estimated ARDL model is free of autocorrelation which is desirable.

Heteroskedasticity test

To verify the assumption that the regression residuals have constant variance, we used the autoregressive conditional heteroskedasticity (ARCH) test and the result is presented in Table 7.

Table 7: LM test for autoregressive conditional heteroskedasticity (ARCH)

lags(p)	chi2	df	Prob > chi2
4	3.586	1	0.0583

Source: Researcher's computation (2025) from STATA 16

The result in Table 7 shows that the null hypothesis of ‘No heteroskedasticity’ is accepted at the 5% level of significance since the p-value of the Chi-Square statistic (0.06) is greater than 0.05. The result implies absence of heteroscedasticity in the estimated model which is desirable.

Normality test

We used the Skewness/Kurtosis tests for Normality to determine whether the model regression residuals are normally distributed. The result is presented below.

Table 8: Skewness/Kurtosis tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	joint Prob>chi2
resid	34	0.0609	0.0902	3.96	0.0521

Source: Researcher’s computation (2025) from STATA 16

The result in Table 8 shows that the p-values of the Skewness and Kurtosis statistics are slightly greater than 0.05 same with the joint result. This means that we do not reject the null hypothesis that the residuals are normally distributed. Thus, there is sufficient evidence to conclude that the residuals of the estimated ARDL model is normally distributed which is desirable.

Alternative estimation: the Kernel-based Regularized Least Squares (KRLS) method

We also employed the KRLS in this study to investigate the impact of exchange rate on cocoa export growth in Nigeria. The KRLS method is a machine learning approach used for regression and classification problems (Hainmueller & Hazlett, 2014). It allows for fitting multidimensional functions without relying on linearity or additivity assumptions. KRLS finds the best-fitting function by minimizing the squared loss of a Tikhonov regularization problem, using Gaussian kernels as radial basis functions (Ferwerda, Hainmueller, & Hazlett, 2017; Hainmueller, & Hazlett, 2014).

The appeal of the KRLS method is that it reduces misspecification bias while still allowing for interpretability and inference, similar to ordinary least squares regression models. Also, it provides closed-form estimates for predicted values, variances, and pointwise partial derivatives, which help analyse the marginal effects of independent variables.

Table 10: KRLS result

lcocexp	Avg.	SE	t	P> t	P25	P50	P75
lexr	.055465	.021146	2.623	0.013	-.045608	.070382	.152038
lgdp	.235984	.036743	6.422	0.000	.027346	.206983	.504216
inf	.001188	.002139	0.555	0.582	-.001604	.0005	.00362

Source: Researcher’s computation (2025) from STATA 16

The result in Table 10 means that a percentage increase in exchange rate (lexr), on average, results in a 0.06% significant increase in the volume of cocoa export (lcocexp), other factors held constant; also, a percentage increase in GDP growth (lgdp), on average, results in a 2.4% significant increase in the volume of cocoa export. In the other results, a percentage increase in inflation (inf) has no significant impact on the volume of cocoa export growth. The result agrees

with that of the ARDL model that exchange rate increase (domestic currency depreciation) is beneficial for the growth of the non-oil export, particularly, cocoa export.

The study further investigated the dynamism of the model using the autoregressive conditional heteroskedasticity (ARCH) time-varying technique. This technique models the variances of the variables rather than the nominal-level or the differenced forms of the data. The result is presented in Table below.

Table 11: The ARCH result

Iteration 14: log likelihood = 40.102546						
ARCH family regression						
Sample: 1986 - 2023			Number of obs		= 38	
Distribution: Gaussian			Wald chi2(3)		= 7858.37	
Log likelihood = 40.10255			Prob > chi2		= 0.0000	
lcocexp	Coef.	OPG Std. Err.	z	P> z	[95% Conf.	Interval]
lcocexp						
lexr	.0795629	.0110998	7.17	0.000	.0578077	.1013182
lgdp	.6362082	.0181714	35.01	0.000	.6005929	.6718234
inf	-.0050342	.0004346	-11.58	0.000	-.0058859	-.0041825
_cons	12.82519	.1568368	81.77	0.000	12.51779	13.13258

ARCH						
arch						
L1.	2.388552	.8283614	2.88	0.004	.7649936	4.012111
_cons	.0000515	.0003898	0.13	0.895	-.0007124	.0008154

Source: Researcher's computation (2025) from STATA 16

The result in the upper segment of Table 11 shows that exchange rate growth has a significant positive impact on the growth of cocoa export in Nigeria, and so does economic growth, whereas higher inflation rates have a negative impact on cocoa export in the country, significant at the 5% level. Additionally, the result in the lower segment shows the variance effect based on the ARCH model of order one (1). The coefficient of the first lag the ARCH factor is 2.39 which is greater than one. This means that the variances of the independent variables contribute to the growth of the variances in the dependent variable. The fact that the coefficient is greater than one implies that the volatilities of exchange rate, GDP, and inflation jointly deepen the variances of cocoa export earning in Nigeria. The result is highly significant at the 1% level which implies that the estimated ARCH model is robust. This is further attested to by the p-value of the Wald statistic ($p = 0.000$).

5. Summary of Findings, Conclusion and Recommendations

This study examined the impact of exchange rate on cocoa export in Nigeria over the period 1986-2023 within a macroeconomic environment featuring gross domestic product (GDP) and inflation rate. Hence, the study estimated the relative impacts of exchange rate, GDP, and inflation rate on cocoa export growth in the country using the autoregressive distributed lag

(ARDL) and the Kernel-based regularised least square (KRLS) methods. The main findings of the study are:

1. A percentage increase in exchange rate (Naira depreciates vis-à-vis the US Dollar) enhances Nigeria's long-run and short-run cocoa export growth by 0.21% and 0.18% respectively. This means that cross-border cocoa trade benefits from the depreciation of the national currency, all other things equal.
2. A percentage increase in the real GDP contributes 0.42% to Nigeria's cocoa export growth in the long-run. This suggests that economic expansion causes cocoa export growth in the country.
3. A percentage increase in inflation rate lowers the country's long-run cocoa export growth by 0.0034%. This means that rising inflation inhibits the growth of cocoa export in the country.

Based on the findings of the study, the study comprehensively examined the impact of exchange rate on export of cocoa in Nigeria between 1986 and 2023, alongside the influence of macroeconomic variables such as GDP and inflation. The analysis employing both the Autoregressive Distributed Lag (ARDL) and Kernel-based Regularized Least Squares (KRLS) methods revealed that a depreciation of the Nigerian Naira positively influences cocoa export growth both in the short and long run, indicating that currency depreciation enhances the competitiveness of Nigerian cocoa in international markets. Moreover, the study found that economic growth, as measured by real GDP, has a substantial positive effect on cocoa export, confirming that broader economic expansion supports increased export capacity.

Conversely, rising inflation was shown to have a detrimental effect on cocoa exports, although relatively small, underscoring the inhibiting role of inflation in the export sector by increasing production costs and reducing global competitiveness. These findings suggest that macroeconomic stability, particularly in inflation control and exchange rate management, coupled with sustained economic growth, is essential for enhancing Nigeria's cocoa export performance. Policy measures aimed at exchange rate stabilization without undermining export competitiveness and inflation control would be critical in supporting this vital agricultural sector for the national economy. The study recommends that,

1. The federal government of Nigeria should stabilise foreign exchange access at the official rate for cocoa producers by prioritising cocoa exporters in forex allocation to ensure they can import necessary inputs like machinery and fertilizers at lower cost.
2. Cocoa producers in Nigeria should leverage on the positive economic growth environment in the country by investing in modern farming techniques, high-yield seedlings, precision agriculture tools, and mechanized equipment to boost productivity and enhance export of the produce.
3. Inflation raises the cost of credit, limiting farmers' ability to invest in modern farm inputs and technologies. The government could establish dedicated agricultural credit facilities offering low interest loans with flexible repayment schedules. These could be paired with financial literacy programs to ensure optimal utilization and timely repayment, thereby enhancing farmers' resilience to inflationary shocks.

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