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Co-Integration Analysis of Cocoa Producer Prices for Ghana, Ivory Coast and Nigeria

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Abstract
West African countries have noticeable effect on the world Cocoa exportation, producing approximately 73% of the world 4million tons of cocoa as at 2012. Among these countries Ghana, Nigeria and Ivory Coast are selected for this study because of different Cocoa market, trade systems and Cocoa policies they have. These countries rank among the first five leading world producers (Ivory Coast, Ghana, Indonesia, Nigeria, and Cameroun). In this study, the long term relationships between cocoa producer prices (CPP), and real exchange rates (RER), in the selected countries were explored by using co-integration analysis. Annual data from 1980 to 2012 was used for this analysis and the data sets were found to be integrated of the same order. It was discovered that while Cocoa producer prices and real exchange rates for Ivory Coast moved together in the long run using Johansen Co-integration Test, it was not the case for Ghana and Nigeria. The Error Correction Model (ECM) applied to search any short term relations and impacts of exchange rate variations on Cocoa producer prices in Ivory Coast showed that both at the short and long run, change in cocoa producer prices influence the real exchange rate (RER) but not the other way round. On the other hand, Ghana and Nigeria Cocoa producer prices and real exchange rates were found not co-integrated. This implies that any form of exchange rate volatility does not influence these countries' real Cocoa producer prices and vice-versa in the long run. The unrestricted Vector Auto-regression Model (VAR) applied in the case of Ghana and Nigeria showed no short term relations between CPP and RER in the two countries as well.
Keywords: Co-integration Analysis, Error Correction Model (ECM), Unrestricted Vector Auto- regression (VAR) Model, Cocoa Export Prices, Real Exchange Rate, Cocoa Producer Prices.

1.0 Introduction

It is believed that the Olmecs (1500- 400BC) first discovered that the cocoa fruit was edible and were almost certainly the first humans to consume chocolate, a major product of cocoa beans. They began cultivating cocoa in equatorial Mexico and cocoa production advanced as people migrated through Meso-America. Its cultivation and value spread in ancient times throughout central and Eastern Amazonian and northwards to Central America. Columbus brought cocoa to Spain from South America in the 16th century. The 17th to 19th centuries witnessed a rapid expansion of cocoa through-out Europe with the discovery of its virtues.

Cocoa arrived in Brazil during the 18th century and from there it was brought to São Tomé in 1822 and then to the island of Fernando Po in West Africa around 1854.

The modern day Cocoa industry goes to as early as 1900 to become the thriving global industry of today. Cocoa is one of the world's oldest crops. Cocoa producing countries that produce Cocoa for their self consumption have been few since ancient times. Nowadays, the trade of the Cocoa volume has increased, trade system improved and new regulations and rules launched in recent decades. The world's Cocoa markets have been influenced also from globalization and over the past decade the capacity of the markets enlarged around the world dramatically. At the same time, globalization, technological revolution, trade liberalization and massive acceptance of cocoa products especially chocolate, cocoa butter and others both as confectionaries and health enhancers have changed the Cocoa world beyond recognition, transforming Cocoa trade into a big foreign exchange earner for the big time West African producers.

Cocoa serves as an important crop around the world: a cash crop for growing countries and a key import for processing and consuming countries. Cocoa travels along a global supply chain crossing countries and continents. The complex production process involves numerous parties including, farmers, buyers, shipping organizations, processors, chocolatiers, and distributers. Cocoa growing plays a key role in agricultural and economic activity. It represents an important contribution to the value of final agricultural output in most of the producer countries. Moreover, at the regional and local levels, the Cocoa growing sector appears to have a conclusive role in agricultural activity and the economy.

During the last 40 years the development of the cocoa industry in West Africa has been marked by changes in the marketing and export structure of the industry and the rate of this change has varied markedly across the region. Large variations in the world market price during the period from 1950 to 1980 led to linked changes in the rate of farm development and in the investment put into important issues such as pest control, the use of fertilizers and the development of higher yielding species. In the 1980s, and more markedly in the 1990s, these price changes were also linked to the demands for economic liberalization led by the International

Monetary Fund (IMF) and the World Bank. Except in Ghana, Governments in the region abolished the marketing boards set up to purchase the cocoa from farmers at a set price and to distribute and sell it on the world market. This left small farmers directly at the mercy of world market prices.

Cocoa exports have been a major source of exportation contributing to national and foreign exchange earnings for these West African countries such as Ghana, Nigeria and Ivory Coast which have noticeable effect on the world Cocoa exportation. Cocoa growing country characteristics may be very different from one Member State to another in the region, not only as regards the degree of specialization of Cocoa- growing holdings, but also as regards the size of the available Land and the volume produced. However, Cocoa production depends heavily on climatic and geographical conditions. The bulk of the cocoa bean output in these countries is exported either as dry bean or processed form.

The cocoa industry has been the mainstay of the economies of Ghana and Ivory Coast. It provides the second largest source of export earnings representing about 30 percent of Ghana's total export earnings in 2004. According to the Bank of Ghana, cocoa bean and products export receipts for the first quarter of 2011 was $859.4 million, accounting for about 61 percent of total export earnings as compared with $682.5 million at 48.8 percent in 2010. In the case of Ivory Coast, through the early 1980s the combined cocoa and coffee tax comprised 20 to 40 percent of the government's revenue. In the case of Nigeria, the oil boom in the early 70s resulted in a significant rural urban migration that led to many youths abandoning the cocoa farms for the city. Even the government commitment towards cocoa as a major source of foreign exchange significantly shifted to oil.

1.1. Cocoa in Ghana, Ivory Coast and Nigeria

The Ivory Coast is little more than one-third the size of Nigeria (322,462 km^2 as against 923,768 km) with a population, according to UN 1982 estimates, one-tenth the size of Nigeria's (8.570.000 as against 82.390.000). Despite this disparity in size and population a comparative study of the two countries seemed of value in terms of providing a perspective on their performance. Additionally, an examination of the mechanisms that have underpinned the extraordinary growth of commercial and export agriculture in the Ivory Coast provides an addition to the debate on development.

For both countries cocoa is currently the most important crop. At independence, Nigeria was second only to Ghana as world producer, reaching peak production in 1970, before beginning a decline that continued until 1982, when it was only 80% of its 1960 level and 64% of 1970 level. Despite this fall in production Nigeria is among the leading group of world producers (Ivory Coast, 25%; Brazil, 22%: Ghana, 10%; Nigeria. 8%; Cameroun 6.75%)[3] with 130.000 metric tons of cocoa (86.66% of its total production) exported in 1982. The production pattern in the Ivory Coast has been altogether different. At independence, the figure for cocoa production was half that of Nigeria's. Thereafter, however, with production increased annually, by 1971 the Ivory Coast had more than doubled its 1960 tonnage, by 1974 it was above that of Nigeria, and in the year 1977-78, replaced Ghana as leading world producer and exporter. By 1980, production had increased four times that for 1960.

It is worthy to note that one major strategy employed by Ghana, Ivory-Coast and Nigeria to increase production has been the introduction of producer prices which the Government raises from time to time in order to stabilize local prices and encourage cocoa farmers. The unstable world market prices of Cocoa which is determined internationally with little or no input from the cocoa producing countries which are mostly African countries has always been a major threat to cocoa farmers. Macroeconomic variables are effective on Cocoa trade. Exchange rate is one of the main macroeconomic indicators. Exchange rates changes affect exports and imports through changes in their relative prices and consequently impact on production. Dornbush et al. (1976), indicate that the exchange rate is identified with the relative prices of goods and thus is a determinant of the allocation of world expenditure between domestic and foreign goods. Appreciations of exchange rate cause trade balance deficit and it affects particularly agricultural products. Therefore the importance of the study is to investigate the association that exists between the real exchange rate volatility and Cocoa producer prices in these countries.

The aim of this study is to use Co-integration analysis to examine the interrelationship between real exchange rate variations and Cocoa producer prices in Ghana, Nigeria and Ivory Coast.

2.0 Materials and Methods

Two variables, Cocoa Producer Price (CPP) and Real Exchange Rate (RER), ranging from 1980 to 2012 are considered in this study which is a period of 32 years. They are annual series for Ghana, Ivory Coast and Nigeria gathered from Central Bank of Nigeria, Bank of Ghana, U.S Department of Agriculture, and International Cocoa Organization (ICCO) respectively. Each country's cocoa producer prices were given in dollars. The real exchange rate data are real weighted exchange rate data. The real weighted exchange rate is equal to the average nominal exchange rate (defined as the price of the dollar in terms of foreign currencies). The data sets were

tested for stationarity by using Augmented Dickey Fuller method to test for the presence of unit roots in the data sets. The order of integration was then determined after differencing the data. The Johansen Co-integration Test was thereafter applied on the series that were found to be integrated of the same order. This was with the intent of determining whether they moved together in the long run or not. If the variables were co-integrated, implying that they moved together in the long run, ECM was applied to search any short term relations and impacts of exchange rate variations on Cocoa producer prices. If there was no co-integration between the variables, implying that there was no long term relationship, the unrestricted VAR was used to determine the presence and direction of any short-term relationship between exchange rate and cocoa producer price.

A long run analysis is investigated by applying the Johansen Co-integration Test. Empirical evidence of same order of integration justifies the co-integration tests and the subsequent use of an Error Correction Models (ECM) in estimating test equations used to analyze the short - run dynamics departures from the long-run equilibrium relation under investigation. The procedures used for stationarity testing, co-integration testing, and the ECM model estimation are described in detail.

3. 0 Theoretical Background

3.1. Stationarity

One major characteristic of non-stationary series is the presence of a unit root. Tests which can be used to check the stationarity of a series are:

3.2 Co-integration Tests

If a group of variables are individually integrated of the same order and there is at least one linear combination of these variables that is stationary, then the variables are said to be co-integrated. The series will move together and be attracted to their long run relationship. There are various methods of co-integration tests namely the Engle – Granger method commonly known as the two-step estimation procedure, the Phillips-Qualiaris methods and the Johansen's procedure, which is the most notable and commonly used, and is the method used in this study.

3.2.1 Johansen's procedure

The Johansen's procedure builds co-integrated variables directly on maximum likelihood estimation instead of relying on OLS estimation.

The method takes as a starting point the vector autoregression (VAR) of order p given by

$$X_t = \pi_1 X_{t-1} + \pi_2 X_{t-2} + \ldots + \pi_p X_{t-p} + U_t \qquad \text{Equation. 1}$$

Where X_t is an n x1 vector of variables that are integrated of order one, that is, I(1), U_t is an $nx1$ vector of innovations while π_1 through π_p are m x m coefficient matrices. Reparameterising equation 1, that is, subtracting X_{t-1} on both sides, leads to

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots + \Gamma_{p-1} \Delta X_{t-p+1} - \pi X_{t-p} + U_t \qquad \text{Equation. 2}$$

Where $\Gamma_1 = \pi_1 - 1$, $\Gamma_2 = \pi_2 - \Gamma_1$, $\Gamma_3 = \pi_3 - \Gamma_2$, and $\pi = 1 - \pi_1 - \pi_2 - \ldots - \pi_p$

The matrix π determines the extent to which the system is co-integrated and is called the impact matrix.

We may write $\pi = \beta\alpha'$ for suitable m x r matrices, β and α'.Then $\pi X_{t-p} = \beta\alpha' X_{t-p}$ and all linear combinations of $\alpha' X_{t-p}$ are stationary.

Johansen's procedure estimates the VAR subject to $\pi = \beta\alpha'$ for various values of r number of co-integration vectors, using the maximum likelihood estimator assuming U_t~iidN (0, Σ). His estimate can thus be rewritten as

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots + \Gamma_{p-1} \Delta X_{t-p+1} - \beta\alpha' X_{t-p} + U_t \qquad \text{Equation 3}$$

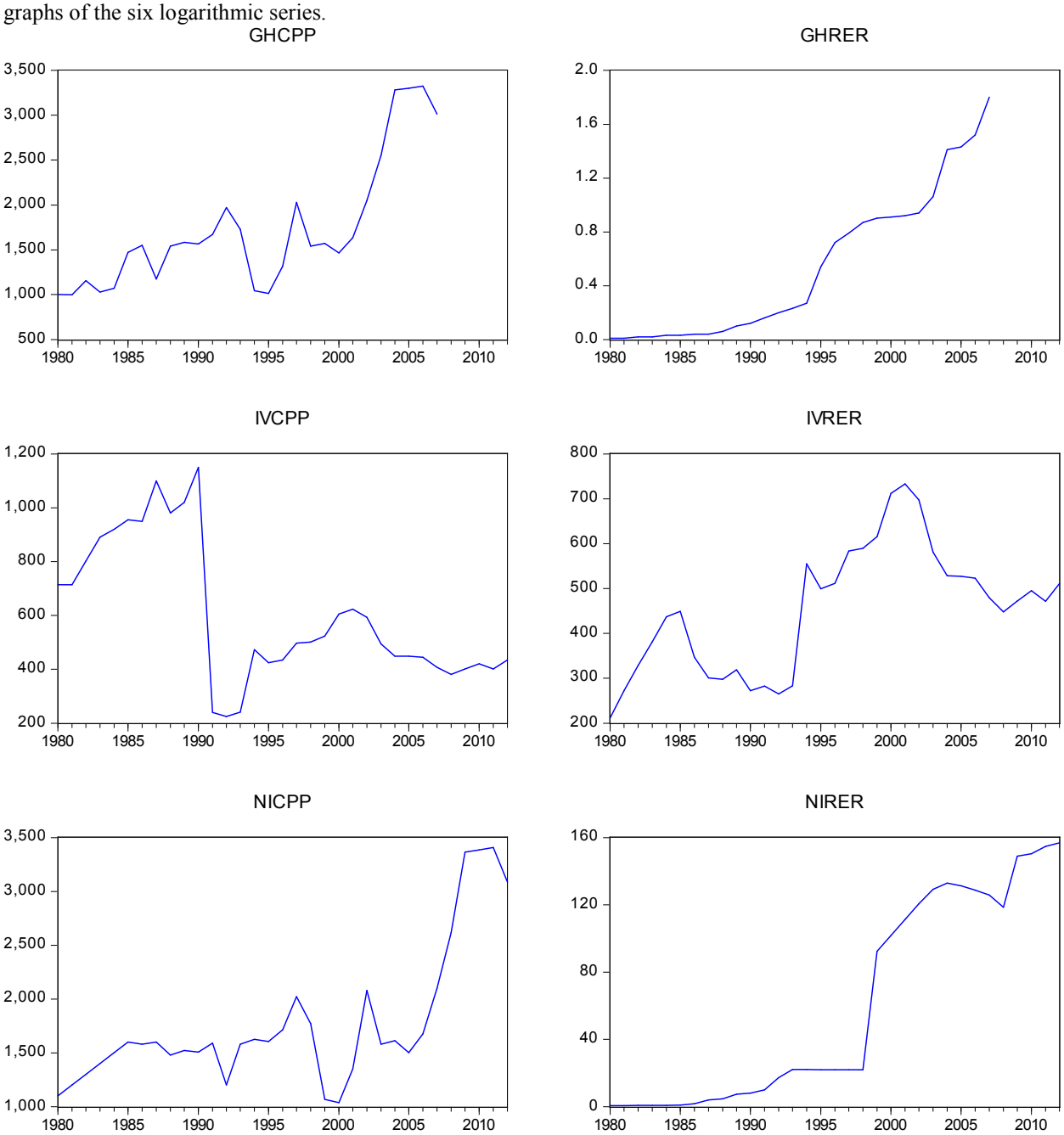
3.2.2 Vector Error Correction (VEC) Model and Granger Causality

In the presence of co-integration, the Granger causality test requires the model to be specified in the more restricted vector error correction (VEC) framework instead of the unrestricted VAR. In the VECM, the long run relationships between series could be determined and the short run variations can be examined through the correction coefficients. The values of the coefficients measure the speed of adjustment between the series. The number of lag periods to be used in estimating the VECM is determined by any of the information criteria. Various lag length selection criteria are defined by different authors like Akaike's (1969) final prediction error (FPE), Akaike Information Criterion (AIC) suggested by Akaike (1974), Schwarz Criterion (SC) (1978) and Hannan-Quinn Information Criterion (HQ) (1979). These criteria mainly indicate the goodness of fit of alternatives (models) so they should be used as complements to the LR test.

4.0 Analysis and Results

The raw data was transformed by taking the natural logarithms of the original series. This helps to avoid the presence of heteroscadasticity among the variables, and also helps to estimate elasticity. Presented below are the

graphs of the six logarithmic series.

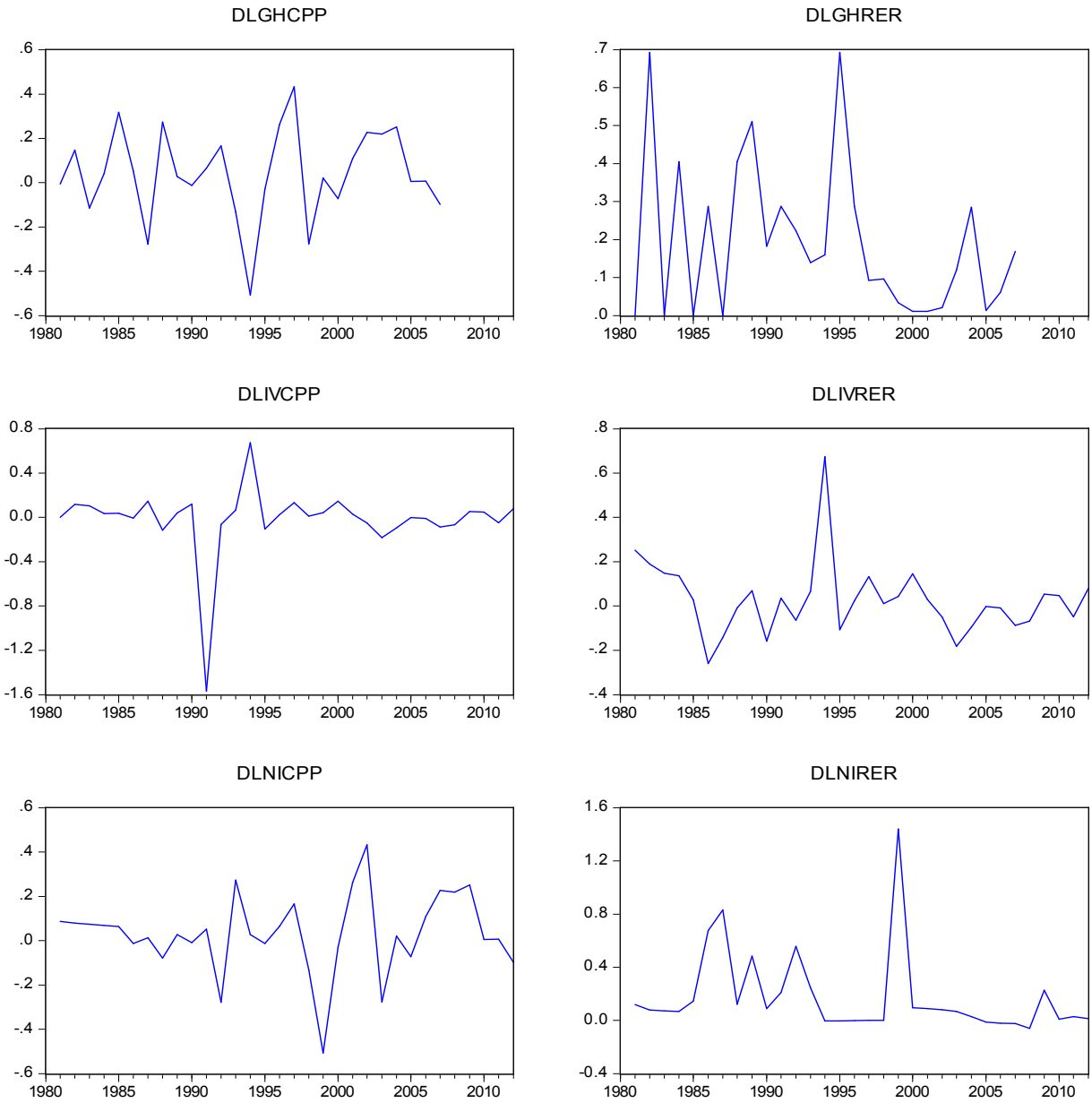


The above graphs show patterns of trends which suggest that none of the series is stationary. For further confirmation, unit root test (Augmented Dickey- Fuller) was performed on the series.

Table 1: Result of Augmented Dickey-Fuller Test

Country	Variables	ADF-Statistic	Phillip-Peron	Mackinon Critical values	Remark
GHANA	LGHCPP	-1.22331	-1.08579	1% =-3.69987	Not stationary
	LGHRER	-1.73628	-1.95300	5% =-2.97626	Not stationary
IVORY-COAST	LIVCPP	-2.10147	-2.13407	10% =-2.62742	Not stationary
	LIVRER	-2.31979	-2.38020		Not stationary
NIGERIA	LNICPP	-1.33725	-1.30932		Not stationary
	LNIRER	-1.66199	-1.66529		Not stationary
GLOBAL	LCEP	-1.15585			

Taking the first difference of all the transformed series LGHCPP, LGHRER, LIVCPP, LIVRER, LNICPP, LNIRER and LCEP, the graphs are presented below.



All the graphs of the differenced series suggest stationarity.

The Augmented Dickey-fuller test was applied to confirm that the series are stationary, that is does not have unit roots.

Table 2: Result of Augmented Dickey-Fuller Test

Country	Variables	ADF-Statistics	Phillip-Perron	Mackinon Critical values	Decision	Integration order
GHANA	DLGHCPP	-5.15819	-9.26314	1% =-3.67017	Reject Ho	I(1)
	DLGHRER	-5.63639	-5.60821	5% =-2.96397	Reject Ho	I(1)
IVORY-COAST	DLIVCPP	-5.53790	-5.57287	10% =-2.62101	Reject Ho	I(1)
	DLIVRER	-4.90097	-4.88345		Reject Ho	I(1)
NIGERIA	DLNICPP	-4.96234	-4.94395		Reject Ho	I(1)
	DLNIRER	-4.83713	-4.83713		Reject Ho	I(1)

4.1 Co-integration Analysis by Country

4.1.1 GHANA

Table 3: Co-integration Test for Ghana

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-50.31922	NA	0.191834	4.024556	4.121332	4.052424
1	14.65333	114.9514*	0.001765*	-0.665641*	-0.375311*	-0.582036*
z2	17.52824	4.644081	0.001940	-0.579095	-0.095212	-0.439755

* indicates lag order selected by the criterion

The above table shows that the lag order selected by the criterion is 1. There is no long run relationship between LGHCPP and LGHRER for Ghana. The summary of the Johansen Co-integration Test as shown in Table 3 is with Lag 1.

Table 4: Johansen Co-Integration Test for RER and CPP

Hypothesis no of CE (S)	Eigen value	Trace Statistics	0.05 critical value	Prob.
None	0.349545	22.0816	29.79707	0.2940
At most 1	0.218479	10.89942	15.49471	0.2177

Trace test indicates no Co-integration at 0.05 significant level.

Under the Johansen Co-integration Test, it could be said that there is no co-integrated vector. The Trace statistics does not reject the null hypothesis of no co-integration among CEP, CPP and RER at the 5% level of significance, showing that the Ghanaian cocoa export value, Cocoa Producer prices and the Real exchange rate are not co-integrated. This suggests that Ghana cocoa market is not affected either by exchange rate volatility or the producer prices in the long run. This means that any change in the exchange rate policy cannot lead to any change in the cocoa export value. In other words, to increase the value of cocoa export in Ghana, exchange rate changes should not be used as a foreign trade policy tool. Since there is no co-integration between the variables, the ECM test cannot be applied. However, because the variables are stationary, the short run relationship can be investigated using Granger causality test in the unrestricted VAR model, as shown in Table 5 below.

Table 5: Pairwise Granger Causality Test for Ghana

Null Hypothesis	Obs.	F-Statistic	Prob.
LGHRER does not Granger Cause LGHCPP	27	2.21911	0.1493
LGHCPP does not Granger Cause LGHRER		0.67814	0.4183

Since the probability values are insignificant at 5% level of significance, exchange rate volatility does not affect cocoa producer prices and vice-versa in Ghana.

4.1.2 IVORY COAST

Table 6: Johansen Co-Integration Test for RER and CPP

Hypothesis no of CE (S)	Eigen Values	Trace Statistics	0.05 critical value	Prob.
None*	0.353558	16.37650	15.49471	0.0368
At most one	0.087898	2.852093	3.841466	0.0913

Trace test indicates 1 co-integrating equation at the 0.05 level.

Table 6 above showed that there is a co-integrated vector since the Trace Statistics is higher than the 5% critical value. Thus, there is a long run relationship between CPP and RER for Ivory-Coast. There is an association between the Ivory Coast cocoa market and the exchange rate volatility in the long run.

4.1.2.1 Error Correction Model

The results of the ECM estimations are as presented below:

Table 7: ECM Estimation for Ivory Coast

Variables	LIVRER	Std. Error	LIVCPP	Std. Error
Co-integration equation	-0.251691*	0.065536	-0.137570	0.117593
D(LIVRER(-1))	0.029568	0.159640	0.394530	0.222645
D(LIVCEV(-1))	0.193775*	0.092669	0.015848	0.383549
C	0.023179	0.024674	-0.025994	0.059281
R-Squared	0.3653		0.094397	
AIC	-1.0546		0.698473	
Durbin-Watson	2.3319		1.98987	
F-statistic	5.179209		0.938126	
Prob.(F-Stat.)	0.005885		0.435899	

*Significant at 5% level

{D(LIVRER) = -0.251691(LIVRER(-1) +0.74589774*LIVCPP(-1) – 10.79568456) +0.029568*D(LIVRER(-1) + 0.193775*D(LIVCPP(-1) + 0.023179}

The significance of the error term coefficient (-0.251691) shows that there is a long run effect of cocoa producer price on the real exchange rate. The negative value of LIVCPP(-1) when the error term is expanded implies that any increase in the previous value of cocoa producer prices leads to a fall in the exchange rate by 0.1877 in the long run . However, the positive value in the coefficient of D(LIVCPP(-1)) implies that any increase in the cocoa producer prices leads to rise in exchange rate (rise in the dollar) by 0.19 in the short run. The results of the ECM estimations are stated at about 25 % of disequilibria "corrected" each year by changes in D (LIVCPP).

D(LIVCPP) = -0.137570(LIVCPP(-1) + 1.338871*LIVRER(-1) – 14.454033) +0.015848*D(LIVCPP(-1) + 0.394530*D(LIVRER(-1) -0.025994

The non-significance of the error term shows that the exchange rate volatility does not significantly affect cocoa producer prices in the long run. Also, the non-significance of D(LIVRER(-1)) coefficient indicates that the volatility of the exchange rate does not influence cocoa producer prices in the short term as well.

4.1.3 NIGERIA

Table 8: Johansen Co-integration Test for RER and CPP

Hypothesis no of CE(S)	Eigen Values	Trace Statistics	0.05 critical value	Prob.
None	0.160526	8.631601	15.49471	0.4006
At most 1	0.098287	3.207226	3.841466	0.0733

From Table 8 above, Johansen Co-integration Test at 5% showed no co-integrated vector for the Nigeria cocoa producer prices and the Real exchange rate. The possible reasons for non co-integration include the little impact of cocoa export on the economy compared to the impact of crude oil since 1970. Apart from that, the fixed exchange rate regime and the subsequent overvaluing of the local currency for some years till the mid 1980s could also be a factor. Since there was no volatility for some years, variables could not co-integrate.

Therefore, unrestricted VAR was used to estimate the regression model coefficients as shown in the table below.

Table 9: Lag Order Selection Criteria for Nigeria

Included observations: 31

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-67.00977	NA	0.294209	4.452243	4.544758	4.482401
1	9.580431	138.3565*	0.002724*	-0.230996*	0.046550*	-0.140523*
2	11.30469	2.892308	0.003169	-0.084174	0.378403	0.066615

* indicates lag order selected by the criterion

Table 10: Unrestricted VAR for Nigeria

Null Hypothesis	Obs.	F-Statistic	Prob.
LNIRER does not Granger Cause LNICPP	32	1.48955	0.2321
LNICPP does not Granger Cause LNIRER		0.15193	0.6996

From Table 10, we can conclude that in Nigeria, the cocoa producer price is not affected by the exchange rate volatility. Similarly, the exchange rate is not influenced by the cocoa producer prices.

For further details, the VAR equations are used to investigate the short term relationships.

Table 11: Coefficient Estimates of VAR

	Coefficient	Std. Error	t-Statistic	Prob.
LNICPP (-1)	0.79372*	0.116920	6.788593	0.0000
LNIRER(-1)	0.02166	0.017753	1.220472	0.2272
C1	1.49894	0.844341	1.775281	0.0811
LNICPP (-1)	0.08047	0.206446	0.389776	0.6981
LNIRER(-1)	0.94895*	0.031347	30.27259	0.0000
C2	-0.27324	1.490853	-0.183278	0.8552

*significant at α=0.05

Equation 1: LNICPP =0.793725 *LNICPP(-1) + 0.021667*LNIRER(-1) + 1.498942

Equation 2: LNIRER = 0.948947*LNIRER(-1) + 0.080468*LNICPP(-1) - 0.273240

Equation 1 showed that LNIRER has no significant impact on LNICPP in the short run, meaning that the exchange rate volatility does not have any significant impact on cocoa producer prices in Nigeria. The significance of LNICPP coefficient however suggests that a unit increase in lagged LNICPP yields an increase of 0.79 on current LNICPP; indicating that previous values of cocoa producer price have the ability to impact 79% on the current cocoa producer price. Similarly, equation 2 showed that a unit increase in lagged LNIRER yields a 95% impact on current LNIRER. This shows that much of the change in the cocoa producer price and exchange rate must have been influenced by either their respective lagged values or some other factors, possibly government policies over some years.

5. Conclusion

In this study, an investigation has been carried out on the impact of real exchange rate variations on cocoa producer prices in some leading cocoa producing countries in West Africa. The countries considered were Ghana, Ivory Coast and Nigeria which are among the five leading cocoa producing countries in the world. Similar studies on cocoa only addressed individual countries but none on comparison of cocoa trade among these countries had been carried out before now.

Though the CPP and RER for the countries were found to be integrated of the same order I(1) in all the countries, the Johansen's co-integration tests carried out for each of the country revealed that only Ivory Coast had its CPP and RER co-integrated, implying that it is only in Ivory Coast that we find cocoa producer prices and exchange rate moving together in the long run. The VEC analysis further revealed that cocoa producer price in a previous year significantly influence the change in real exchange rate in the current year both in the long and short runs.

On the other hand, the Nigeria and Ghana Cocoa producer prices and the real exchange rate were not co-integrated. Thus, any exchange rate policy changes did not impact changes to their cocoa producer prices and vice-versa in the long run. The short term analysis also revealed that there was no existing relationship between the cocoa producer prices and exchange rates for the period under investigation.

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