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Co-integration and Error-correction Modelling of Agricultural Export Trade in Nigeria: The Case of Cocoa

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ABSTRACT

The cocoa sub-sector has received increased attention as part of the current Federal Government's Economic Reform Agenda of diversifying the nation's export base from petroleum. This paper argues that in the face of the trending down of the growth of cocoa output over time, exports may not have been responding positively to prices and non-price variables. Consequently, this study investigates this concern by estimating cocoa export supply in Nigeria from 1970 to 2003 in the context of co-integration and error correction modelling approach using data from the Central Bank of Nigeria (CBN), Food and Agriculture Organisation (FAO) of the United Nations and the International Financial Statistics (IFS) of the International Monetary Fund (IMF). Results reveal that the error correction mechanism (ECM) shows that any disequibria away from the long-run steady-state equilibrium of cocoa exports is corrected within one year. Specifically, the speed at which cocoa export supply adjusts to changes in real producer price, trading partners' income and lagged cocoa export supply in an effort to achieve long-run static equilibrium is 78.75%. In the short-run, real cocoa producer price has significant but negative effect on cocoa export supply. However, in the long-run, the effect of real producer price on cocoa export supply is significant, positive and inelastic. Foreign income indicates a negative but non-significant effect on export supply in both the short and long-run. These results, among others show that there may be a promise for increased cocoa exports in the long-run, when it would have been possible for harvested hectarage to be expanded and/or existing low-yielding and aged trees replaced. Overall, increased domestic production and increase in domestic industrial utilisation will increase income and price elasticities of its manufactured exports compared with primary products.

Key Words: Cocoa exports; Prices; Economic reform; Industrial utilisation; Error correction mechanism

INTRODUCTION

Cocoa has been a leading agricultural export commodity and major source of foreign exchange earnings and economic development in Nigeria over time (Olayide, 1969; Olayide & Olatunbosun, 1972; Olayemi, 1973; Ajayi & Oyejide, 1974; Abang, 1984; Olalekun, 1985; Falekulo, 1985, Abang & Ndifon, 2002; Nkang *et al.*, 2006). As the number one commodity in the agricultural export list in Nigeria's, its production, domestic consumption and exports have remained a central concern of government and importing countries alike. Recently the Presidential Initiative on Cocoa in Nigeria held a Cocoa Stakeholders Forum in Calabar, Cross River State to deliberate on the state of the cocoa sub-sector and to reach consensus on the way forward for the cocoa industry. Although advanced importing countries have increasingly been dependent on other natural substitutes of cocoa butter (the major semi-finished product from cocoa beans) such as palm kernel Olein and palm kernels Stearin and coconut fat, etc., the unique chemical composition of pure cocoa butter remains unbeatable, thus cocoa remains an important agricultural export in the world (see for example, American Palm Oil Council, 2006).

Statistics from the Central Bank of Nigeria (CBN) summarised in Table I, between 1970 and 2002 show that the fortunes of the cocoa exports have been dwindling. For instance, between 1970 and 1985 cocoa exports grew at -0.66%, while the growth rate of exports between 1986 and 2002 was 9.44%. However, between 1970 and 2002, export growth stood at an annual average of 4.68%.

In contrast, the growth rate of cocoa production between 1970 and 1985 was -3.47%, while it was 7.02% between 1986 and 2002. For the entire period from 1970 to 2002, the average annual growth rate of cocoa production stood at 2.0%.

Clearly, the univariate analysis above shows that cocoa export supply and domestic absorption were growing faster than domestic cocoa production in Nigeria. Undoubtedly, if production is not keeping pace with supply, common sense would suggest that supply cannot increase much more than what is produced, thus even in the event of a price increase, more of cocoa may not be supplied.

Several studies have estimated the export supply of cocoa in Nigeria with satisfactory estimates of price elasticities of exports. In these studies, positive price elasticities have been reported. However, the analysis of growth rates of cocoa production, consumption and exports captured above indicate a possibility of very small price elasticities or even an inverse relationship between exports and prices and therefore casts some doubts on the results of these studies.

Consequently, this study investigates this problem using cointegration and error correction approach, which is widely acclaimed to be more suitable for time-series modelling than previous attempts for Nigeria.

Particularly, it estimates short and long-run elasticities of price changes, foreign income, government policy and exogenous shocks on cocoa export supply in Nigeria from 1970 to 2003 and tests the estimated model for structural stability in the face of perceived structural breaks in the economy.

The rest of the paper is organised as follows: the section, which comes next presents the methods used in the empirical analyses, comprising the model, model specification and implementation procedures as well as the data. Section 3 covers the estimation results and discussion, while the last section concludes with policy implications.

Table I. Average annual growth rates (%) of cocoa production, domestic consumption and export in Nigeria (1970-2002)

Period	Production	Domestic Consumption	Export
1970-1985	–3.47	18.75	–0.66
1986-2002	7.02	99.06	9.44
1970-2002	2.0	62.0	4.68

Source: Derived from various issues of the CBN Statistical Bulletin, Annual Reports

METHODOLOGY

The model. The model for this study is a modification of the basic export supply equation of the Imperfect Substitutes Model of foreign trade. The key assumption of this model is that exports are not perfect substitutes for domestic goods in importing countries. The basic model contains eight equations for quantities and prices of trade between a country and the rest of the world (Goldstein & Khan, 1985; Marquez & McNeilly, 1988) and the export supply equation is given as:

$$X^S = \xi(P^X(1+S), P) \quad \xi_1 > 0, \xi_2 < 0 \ldots\ldots\ (2.1)$$

Where,

X^S = the quantity of the home country exports to the rest of the world

P^X = prices in domestic currency paid to the exporters

P = prices of domestic commodities produced within the regions

ξ_1 and ξ_2 are parameters.

In most modifications of the basic equation, the price terms P^X and P enter the estimation equation as a relative price measure since their joint inclusion as in equation (2.1) may lead to multicollinearity.

Since the theory underlying export supply is the traditional supply response to changes in price and non-price factors, we specify an export supply function cast in the imperfect substitutes model framework and founded on the traditional supply response theory with the exclusion of export subsidies and inclusion of non-price variables as in Tambi (1999) and Gbetnkom and Khan (2002) thus:

$$\ln YC_t = \lambda_0 + \lambda_1 \ln RPD_t + \lambda_2 \ln REP_t + \lambda_3 \ln RNF_t + \lambda_4 \ln YC_{t-1} + \lambda_5 \ln TWY_t + \lambda_6 \ln TRD_t + \lambda_7 DMY_t + \mu_t \ldots\ldots (2.2)$$

Where,

YC_t = export supply of cocoa measured in tons

RPD_t = (PP_t / DPI_t) the ratio of the producer price to the domestic price index

REP_t = (EP_t / DPI_t) the ratio of the export price to the domestic price index

RNF_t = average annual rainfall in millimetres

TWY_t = trade-weighted income of major Nigerian trading partners

TRD_t = trend variable to capture technological changes in production and export processes

DMY_t = dummy variable for liberalisation of both domestic and export marketing activities, which takes the value of 0 for years prior to the liberalisation and 1 for years thereafter.

μ_t = stochastic error term assumed to be independently and normally distributed with zero mean and constant variance.

A priori, $\lambda_1 \ldots \lambda_6 > 0$, while $0 > \lambda_7 > 0$.

Model implementation techniques. The model was implemented within the cointegration and error correction testing framework, which bypasses the problems of spurious regressions caused by non-stationary time series data and which at the same time provides information on long-run relationships as well as short-term dynamics in the same model.

Specifically, the study adopts Engle and Granger (1987) two-step procedure in co-integration. In this method, the first stage involves a preliminary analysis to find the order of integration of the data series and after that ordinary least squares regression is carried out to estimate the equations for those economic aggregates, where co-integration can be found (Engle & Granger, 1987; Adam, 1992). These are the stationarity test (unit root test) and co-integration test, respectively. In the second stage, the residuals obtained in the long-run co-integration regression are used as explanatory variable to specify a dynamic error correction model, which is estimated via ordinary least squares (OLS) regression.

This approach is necessary, because it has been found that a large number of time-series used in econometric analysis are non-stationary, which means they have tendency to increase or decrease over time. The consequence of this behaviour is that the asymptotic convergence theorems (such as Weak Law of Large Numbers), which underpin statistical estimation theory are violated and hence such data should not be used in regression, since such regressions yield spurious results (Granger & Newbold, 1974; Philips, 1986).

Test for stationarity (Unit root tests). Consider the simple first order autoregressive, AR (1) model shown in equation (2.3) below. A stationary series is one where $|\rho| < 1$. The series have a finite variance, transitory innovations from the mean and a tendency for the series to return to their mean value. This means that a stationary series Y_t for example has a mean, variance and autocorrelation that is constant over time, implying that the error structure is time invariant (Adam, 1992; Tambi, 1999; Niemi, 2003).

In contrast, a non-stationary series is one where $|\rho| \geq 1$. It has a variance, which is asymptotically infinite; the series rarely crosses the mean and innovations to the series are permanent. That is any stochastic shock may not return to a proper mean level. A classic example of a non-stationary series is a random walk where $|\rho| = 1$. Thus, Y_t is said to be integrated of order *I (1)*. Since ρ is unity, *Y* is said to have a "unit root".

$$Y_t = \alpha + \rho Y_{t-1} + \mu_t \text{ ………………… (2.3)}$$

A non-stationary time series has important asymptotic consequences: regression estimates do not converge in probability with increased sample size R-square values have non-degenerate distributions and divergence in t-value distributions often exist such that asymptotically correct critical values do not exist. Regressions involving non-stationary variables in levels often display first-order serial correlation and lead to spurious results.

To carry out the unit root test for stationarity, we used the Augmented Dickey-Fuller (ADF) test to examine each of the variables for the presence of a unit root (an indication of non-stationarity) since the Dickey Fuller (DF) test assumes that the data generating process (DGP) is a first order autoregressive ($AR(1)$) process, thus if the DGP is a higher process, autocorrelation in the error term will bias the test. So the ADF is used to avoid such bias in the test since it includes the first difference in lags in such a way that the error term is distributed as white noise. The test formula for the DF and ADF are shown in equations (2.4) and (2.5), respectively.

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \mu_t \text{ ………………. (2.4)}$$

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \sum_{t-1}^{j} \gamma \Delta Y_{t-j} + \mu_t \text{ ………. (2.5)}$$

Where the lag length *j* chosen for ADF ensures that μ_t is empirical white noise.

Here the significance of ρ is tested against the null that ρ = 0, based on t-statistics on ρ obtained from the OLS estimates of equations (2.4) and (2.5). Thus if the null hypothesis of non-stationarity cannot be rejected, the variables are differenced until they become stationary, that is until the existence of a unit root is rejected. We then proceed to test for cointegration.

Test for co-integration. Co-integration is said to exist between non-stationary variables if their linear combination, namely the residuals of the co-integrating regression are stationary (Granger, 1986; Hendry, 1986). Thus, spuriousness can only be avoided if a stationary co-integrating relationship is established between the variables. The particular relevance of the error correction form is the modelling of cointegrated series. According to Engle and Granger (1987), when variables are cointegrated there exist a valid error correction model describing their relationship, with the implication that cointegration between variables involved is a precondition for the error correction model.

In testing for cointegration, we apply the ADF test to the residuals of the co-integrating regression rather than the levels of the series. If the residuals of the bivariate or multivariate co-integrating regressions are found to be stationary, implying co-integration, we will then specify an error correction model, which is the second step of the Engle-Granger two-step method.

Following Engle and Granger (1987), the co-integration regression between Y_t and Z_t can be specified thus:

$$Y_t = \alpha_0 + \alpha_1 Z_t + \varepsilon_t \text{ ………..………... (2.6)}$$

The residuals of the co-integration equation (2.6), $\varepsilon_t = (Y_t - \alpha_0 - \alpha_1 Z_t)$ is simply a linear difference of the non-stationary series (i.e., Y_t - Z_t).

The ADF test equation based on the residuals is given as:

$$\Delta \hat{\varepsilon}_t = \phi + \beta \hat{\varepsilon}_{t-1} + \sum_{t-1}^{j} \lambda \Delta \hat{\varepsilon}_{t-j} + v_t \text{ ……. (2.7)}$$

The test statistic, as indicated earlier, is a t-ratio for $\beta = 0$. If this null hypothesis cannot be rejected against the alternative that $\beta < 0$, then the variables are not cointegrated, on the other hand if the null hypothesis is rejected then the conclusion would be that the estimated ε_t is stationary (that is, does not have a unit root). In our estimations, bivariate and multivariate co-integrating regressions were carried out between the export supply of cocoa and the price variables and income to establish the existence of long-run cointegrating relationship.

Finally, in stage two, the residuals of the valid multivariate co-integrating regressions were included in the model as explanatory variable, before it was estimated with the use of ordinary least squares regression.

From the example in equation (2.6), the error correction mechanism (ECM) can be specified as:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta \bar{Z} - \alpha_2 (Y_t - Z_t)_{t-1} + \varepsilon_t \text{ ………… (2.8)}$$

Where,

$\overline{Z}$ = the vector of explanatory variables

Y_t and Z_t = the co-integrating variables

α_2 = the error correction mechanism (ECM)

α_1 = the vector of parameters.

The data. The data for this research are annual and were obtained from several sources. These included the Central Bank of Nigeria (CBN), Federal Office of Statistics (FOS), Food and Agriculture Organisation (FAO) of the United Nations and International Financial Statistics (IFS) of the International Monetary Fund.

Precisely, data on consumer price index (CPI), producer price, the export price and rainfall between 1970 and 2003 were collected from the real sector and price statistics of the CBN. Statistics of export quantities of commodities were sourced from the FAO, while income of major trading partner countries were gotten from the IFS.

Apart from producer price data obtained from various issues of the CBN Annual Reports, all the data were downloaded from the respective websites of the organisations mentioned above. They include www.cenbank.org (CBN), www.fao.org (FAO), www.ifs.org (IFS).

ESTIMATION RESULTS AND DISCUSSION

Test for stationarity. Table II shows the results of unit root (stationarity) tests for each of the variables modelled in the cocoa export supply function. The results indicate that cocoa export supply quantity (LnYCt) and trading partners' income (LnTWYt) were stationary at their levels, while the two price variables, namely the real producer price (LnRPDt) and real export price (LnREPt) were not. As can be observed from the table, the null hypothesis of the presence of a unit root cannot be rejected for those two variables as it is clear that the critical ADF values are larger in absolute terms than the corresponding calculated values.

On application of the ADF test on their first difference terms, they became stationary as suggested by the t-values of the ADF test, which are larger (in absolute terms) than the standard critical values.

These results indicate that the two price variables are integrated of order 1, that is, are *I (1)*. Having assessed the univariate time-series characteristics of the individual data series, we now turn to the next step in the current method of estimation, which is the tests for cointegration (cointegration being a precondition for the specification of an error correction model).

Engle and granger co-integration tests. Table III shows the results of the Engle-Granger co-integration regression and test statistics. From the table, the results of the bivariate cointegration regression for cocoa export supply and each of the other variables indicate the presence of cointegration (except for LnREPt) as indicated by the stationarity of the residuals of the static regression. The calculated ADF statistic for LnREPt did not indicate the existence of co-integration between this variable and cocoa export supply as evident in a lower value of the ADF statistic of -4.1471 compared with the critical value of -4.2627.

However, when the test was applied to the residuals of all of the variables taken together (see Table IV), the residuals were stationary indicating that there exist a long-run cointegrating relationship between LnYCt and all of LnREPt, LnRPDt and LnTWYt. Hence, we say that the residuals are integrated of order 0, that is, I (0). Consequently, we specify an error correction model for cocoa export supply, which includes the residuals from the static cointegration regression between cocoa export supply quantity and the above-named three variables, as an explanatory variable, called the error correction term, in the model specification.

Over-parameterised error-correction model for cocoa. The results of the estimates of the over-parameterised error correction model for cocoa are presented in Table IV. Although the model looks fairly well estimated, it cannot be interpreted in its present form. The basic essence of the

Table II. Results of Augmented Dickey Fuller (ADF) unit root tests with trend for individual series

Variable Level	ADF statistic	Critical value 1%	Variable First Difference	ADF statistic	Critical value1%
LnYCt	-4.3568	-4.2627	ΔLnYCt	-5.0146	-4.3239
LnRPDt	-2.4897	-4.2627	ΔLnRPDt	-6.6143	-4.3239
LnREPt	-2.3699	-4.2627	ΔLnREPt	-5.5830	-4.3239
LnTWYt	-5.3427	-4.2627	ΔLnTWYt	-9.4165	-4.3239

Critical values of ADF tests are based on MacKinnon (1996) one-sided p-values. Lag length selection is automatic based on Eviews Schwarz Information Criteria

Table III. Results of ADF tests on residuals of cointegrating regressions

	Long-run coefficients (t-statistics)	Residual Level ADF statistics	Residual Level Critical value 1%
LnYCt on LnRPDt	0.3349 (4.1583)	-4.9714	-4.2627
LnYCt on LnREPt	-0.0296 (-1.3730)	-4.1471	-4.2627
LnYCt on Ln TWYt	-0.1094 (-1.9801)	-4.8918	-4.2627
LnYCt on all three	See table 4.3 for coefficients	-5.577	-4.2627

Critical values of ADF tests are based on MacKinnon (1996) one-sided p-values. Lag length selection is automatic based on Eviews Schwarz Information Criteria

Table IV. Estimates of long-run cointegrating regression and diagnostics, Sample: 1970 -2003, Dependent variable: LnYCt

Variable	Coefficient	Std. error	t-statistic	Probability
LnRPDt	0.3090	0.0889	3.4738	0.0016
LnREPt	0.01068	0.03019	0.35401	0.7258
LnTWYt	-0.0626	0.08175	-0.7662	0.4495
Constant	11.4222	0.74290	15.3752	0.0000

R^2 = 0.36611; R^2 = 0.3027; σ = 0.2124; DW = 2.017; F (3, 31) = 5.7758[0.0030]

Akaike Information Criteria (AIC) = -0.15035; Schwarz Criteria (SC) = 0.02921 over-parameterised specification is to capture the main dynamic processes in the model. It sets the lag length such that the dynamic processes would not be constrained by too short a lag length. As is evident in the over-parameterised specification the lag length was set at three bearing in mind the possible problems of low degrees of freedom if higher order lags are used.

As is traditional, the over-parameterised model was reduced to achieve a parsimonious model, which is both data admissible theory consistent and interpretable. Parsimony maximizes the goodness of fit of the model with a minimum number of explanatory variables. The reduction process is mostly guided by statistical considerations, intuition and luck rather than economic theory (Adam, 1992). Thus, our parsimonious reduction process made use of a stepwise regression procedure, subjecting each stage of the reduction process to several diagnostic tests before finally arriving at an interpretable model.

Parsimonious error correction model for cocoa. Table VI depicts the parsimonious error-correction model. Clearly, the interpretation of the dynamic process in this model is easy. Thus, we base the discussion on the parameter estimates on these model as well as the long-run estimates in Table IV.

It can be observed that the parsimonious model has a better fit compared with the over-parameterised model, as indicated by a higher value of the F-statistic (7.2545), which is significant at the 1% level of significance compared with the F-statistic (3.4486) of the over-parameterised model, which is significant at the 5% significance level.

The structural variables of the reduced model explain the export supply of cocoa better than the over-parameterised model as indicated by the values of their adjusted coefficients of multiple determination. Specifically, the adjusted R^2 for the reduced model (0.5933) is higher than the adjusted R^2 of the over-parameterised model (0.5663). Similar evidence is given by the value of the standard error of the regression (σ), Durbin-Watson (DW) statistic for first-order serial correlation and the two model information criteria (that is Akaike & Schwarz information criteria). A model with lower standard error of the regression is preferred in terms of a rival model. This also applies to the values of the Schwarz information criteria (SC) and the Akaike information criteria (AIC).

A series of other diagnostic tests were applied to the model in order to test the validity of its estimates and their suitability for policy discussions. On the whole, three residual tests aside the DW test for first order serial correlation were carried out to test the normality and independence of the residuals of the preferred model.

The Jarque-Bera Normality test on the residuals, with F-statistic of 1.8647, could not reject the null hypothesis of normality in the residuals, as indicated by the level of significance shown in the table above.

Furthermore, the Breusch-Godfrey serial correlation Lagrange Multiplier (LM) test for higher order serial correlation with a calculated F-statistic of 0.179 could also not reject the null hypothesis of absence of serial correlation in the residuals.

Table V. Estimates of over-parameterised error correction model, Sample: 1970-2000, Dependent variable: LnYCt

Variable	Coefficient	Std. error	t-statistic	Probability
LnYCt(1)	-1.4769	1.0377	-1.4223	0.1765
LnYCt(2)	-0.0526	0.1926	-0.2731	0.7887
LnYCt(3)	0.39161	0.1728	2.2659	0.0398
ΔlnRPDt(1)	-0.2769	0.1134	-2.4422	0.0285
ΔlnRPDt(2)	-0.6356	0.3071	-2.0692	0.0575
ΔlnRPDt(3)	-0.5631	0.1761	-3.1970	0.0065
ΔlnREPt(1)	0.1851	0.1115	1.6603	0.1191
ΔlnREPt(2)	-0.0036	0.1024	-0.0352	0.9724
ΔlnREPt(3)	-0.0589	0.1364	-0.4317	0.6725
LnTWYt(1)	-0.0978	0.0978	-1.0000	0.3340
LnTWYt(2)	0.0465	0.0903	0.5151	0.6145
LnTWYt(3)	-0.0432	0.0918	-0.4708	0.6450
ECMt(1)	-1.2327	0.9947	1.2393	0.2356
Constant	24.2378	11.9917	2.0212	0.0620
LnRNFt	0.4957	0.2044	2.4241	0.0295
LnT	-0.4086	0.2167	-1.8852	0.0803
DMY	0.4405	0.2812	1.5667	0.1395

R^2 = 0.7976; Adjusted R^2 = 0.5663; σ = 0.1694; DW = 2.4760; F (16, 15) = 3.4486[0.0123]
AIC = -0.4104; SC = 0.3759

Table VI. Estimates of parsimonious error correction model, Sample: 1970-2000, Dependent variable: LnYCt

Variable	Coefficient	Std. error	t-statistic	Probability
LnYCt(1)	0.6436	0.2916	2.2070	0.0376
ΔlnRPDt(1)	-0.3256	0.1020	-3.1917	0.0041
ΔlnRPDt(3)	-0.2293	0.1013	-2.2631	0.0334
LnTWYt(1)	-0.0887	0.0681	-1.3027	0.2056
ECMt(1)	-0.7875	0.3128	-2.5173	0.0192
Constant	2.9573	3.8708	0.7640	0.4526
LnRNFt	0.3503	0.17033	2.0567	0.0502
LnT	-0.0182	0.0715	-0.2545	0.8013
		Diagnostics		
J-B F-stat		1.8647[0.3936]		
B-G LM test F-stat		0.1790[0.8373]		
ARCH test F-stat		1.0953[0.3042]		

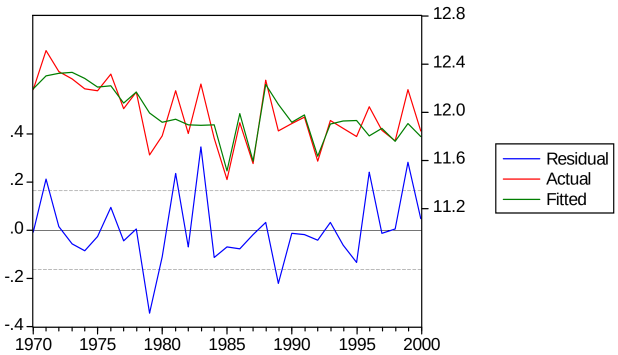
R^2 = 0.6882; Adjusted R^2 = 0.5933; σ = 0.1640; DW stat. = 2.2353; F (7, 24) = 7.2545[0.0001] AIC = -0.5591; SC = -0.1890

Finally, the Autoregressive Conditional Heteroskedasticty (ARCH) test was used to test for heteroskedasticity in the error process in the model. The results of the calculated F- statistics (1.0953) indicated absence of heteroskedasticity in the model.

From the battery of diagnostics tests presented and discussed above we conclude that the model is well estimated and that the observed data fits the model specification adequately, thus we expect that the residuals are distributed as white noise and the coefficients valid for policy discussions.

The residual graph, which shows the actual and fitted observations is depicted below in Fig. 1. It indicates that the fitted observations are as close as possible to their observed value, which is the hallmark of Least Squares estimation. Next, the estimates of the short and long-run elasticities as

Fig. 1. Residual Graph of Parsimonious model



well as the error correction mechanism are discussed.

It can be observed from the results that the coefficient of the error correction term ECM (1) carries the expected negative sign and it is highly significant at the 5% level of significance. The significance of the error correction mechanism (ECM) supports cointegration and suggests the existence of long-run steady-state equilibrium between cocoa export supply and real producer price of cocoa and trading partners' income. In fact, the ECM indicates a feedback of about 78.75% of the previous year's disequilibrium from long-run elasticity of real cocoa producer price and trading partners' income. In other words, the coefficient of the error correction term measures the speed at which cocoa export supply adjusts to changes in real producer price and trading partners' income in an effort to achieve long-run static equilibrium. We can say the speed of adjustment is high.

The short-run coefficient of the real cocoa producer price lagged one period carries a negative sign but is significant at the 1% level of significance. In the same manner, the three year lag coefficient also carries a negative sign but significant at 5% significance level. However, in the long-run the coefficient of the real producer price is positive as expected and significant at the 1% significance level.

Notice that in the short-run, export supply of cocoa responds both to prices in the first year, then the third year. In fact, in the first year of a price change, a 10% increase in price reduces export supply by 3.25%, while it is reduced by approximately 2.3% in the third year. If we play down on the signs of these coefficients, these results are respectively consistent with the keeping of buffer stock and the fact that harvesting of new crop can begin in the third year of planting.

However, when taken together in the short-run, a 10% increase in the real cocoa producer price leads to reduction of cocoa export supply by 5.55% (i.e., we add -0.325 6 & -0.2293 to give us the total short-run effect), while a 10% increase in the real cocoa producer price would lead to a 3.09% increase in export supply in the long-run. Thus, in both the short and long-run cocoa export supply is inelastic to real producer price changes.

The implications of these results are severe. For the real producer price variable in the short-run, the negative coefficient is not as appalling, as evidence has shown that cocoa output hence export supply has been trending down for many years. In fact, empirical studies by Onyenweaku and Madu (1991) on the supply response of Nigeria's cocoa showed evidence of negative output even in the face of rising cocoa producer prices.

They argue that the price factor has been almost over-swamped by non-price factors, which are non-agricultural, such as over reliance on the oil sector. Another probable reason for the negative short-run price elasticity's include failure of farmers to replace their old and low-yielding cocoa trees with young high yielding ones. Beyond these, rising production costs especially labour costs are known to partially offset output price increases.

Further evidence on the export supply responsiveness to price in the short-run is provided by the negative coefficient of the trend variable. Though not statistically significant at 10% significance level or less it indicates that technological improvements have not favoured the supply of cocoa exports over time, particularly in the area of cocoa production. Beyond these, increased domestic absorption of cocoa over time could be another important factor that may be responsible for the negative export supply responsiveness of cocoa to real producer prices in the short-run.

The coefficient of trading partners' income was negative and non-significant at 10% or less in both the short and long-run. The sign indicates that increase in trading partners' income reduced cocoa export supply from Nigeria, in both the short and long-run. This result is consistent with the use of substitutes for cocoa in the manufacture of beverages and confectionaries in the advanced countries that are mostly the importers of Nigeria's cocoa.

The coefficient of the lagged endogenous variable is positive and significant at the 5% significance level. The value of the coefficient suggests that if previous year's export supply increases by 10%, the current years export supply will increase by a less than proportionate amount of 6.43%.

Rainfall coefficient is positive and significant at the 10% level of significance. This implies that adequate rainfall is required for increased cocoa export supply.

Test for model stability. The result of the test for model stability using the Chow Break Point test for 1985 has an F-statistic of 1.875 and p-value of 0.132. This result implies that the null hypothesis of model stability cannot be rejected. Thus, we conclude that the estimated export supply function for cocoa has been structurally stable. That is the export supply function cocoa before liberalization is the same with the cocoa export supply function after liberalization. The significance of the structural stability of this function is that the parameters of the export supply function are constant and do not change over time. This makes it possible for the model to be used on post sample data or in policy simulations.

CONCLUSIONS AND POLICY IMPLICATIONS

The study examined cocoa exports supply in Nigeria from 1970 to 2003 using cointegration and error correction approach. The specific objectives of the study were to estimate short-and long-run effects of price changes, foreign income, government policy and exogenous shocks on cocoa exports supply and to test for structural stability in the estimated cocoa export supply functions before and after market liberalization.

It is very clear that cocoa exports supply has been responding negatively to real producer prices in the short-run. However, the response of cocoa export supply to real producer price in the long-run is positive and inelastic.

These results show that there may be a promise for increased cocoa exports in the long-run, when it would have been possible for harvested hectarage to be expanded and/or existing low-yielding and aged trees replaced. This would, however, depend on the domestic utilization capacity. Nonetheless, with increased reliance on other substitutes by importing countries, the export supply response might even be more inelastic if not negative in the long-run.

In view of the findings of this study, it is recommended that low-yielding and old cocoa trees, which have exceeded optimum production age should be replaced with high-yielding ones. In addition to this, furthering cocoa research will reduce disease incidence thus increasing total output, (which is a combination of domestic consumption & export quantity) and reversing the negative output trend over time.

Overall, with increased domestic production, increase in domestic industrial utilization will increase the income and price elasticities of its manufactured exports compared with the primary products.

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