Determinants of timber exports in Nigeria: an error correction modeling approach

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1 April 2007

DETERMINANTS OF TIMBER EXPORTS IN NIGERIA: AN ERROR CORRECTION MODELING APPROACH

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Abstract

This study analyzed the factors influencing the exports of timber in Nigeria with the aid of Error Correction Model (ECM) representation procedures. The analysis was carried out with the data collected on roundwood and sawnwood over 33 years (1970 – 2003) using the long run restricted ECM. The statistical significance of the ECM terms for roundwood (-1.110) and sawnwood (-1.772) validates the existence of relationship among the variables. This suggests the short run dynamic effect of the changes in export quantities of roundwood are determined by one-year lagged export quantity of roundwood & domestic output-consumption ratio of roundwood, domestic output-consumption ratio of roundwood and domestic-international price ratio of roundwood, while that of sawnwood is determined by lagged values of the official exchange rate, domestic consumption-output, domestic consumption-output and world export-output ratios of the sawnwood. Efforts to boost timber export from Nigeria needs to incorporate policy measures that will improve the quantity and quality of timber products in order to meet the local and foreign demands.

Keywords: Roundwood, Sawnwood, Nigeria, Exports, Co-integration and Error-correction model

Introduction

Timber production has contributed immensely to the Nigerian economy in terms of exports and also domestically as a source of raw materials to wood based industries like pulp and paper, furniture, match, and the saw-milling industries etc. It also helps in the development of the immediate environment that surrounds forest areas. It started generating revenue for the country as far back as 1846 when sawn wood and logs were supplied to industrialized countries such as Western Europe (FVTC, 1996). In 1975 – 1980, there was a ban on wood exports to encourage the establishment of wood based industries to make use of raw materials. The World Bank in 1994 reported that exported commodities contributed more than 83.5% of the total foreign exchange earnings of Nigeria in the late 1960s. However, in spite of Nigeria's vast wealth in agricultural and forest resources, there has been a decline in the contribution of the agricultural and forest export commodities to the export in recent time and this decline has lowered their importance as foreign exchange earners (Yusuf, 2000).

However, due to the continuous high level fluctuations in oil prices; the estimated low reserves of the country's crude oil; as well as, the continued increase in the demand for woods and wood products in Nigeria and the world over (FAO, 1995), there is an urgent need to increase timber output in order to meet its local and international demands. This will serve as prerequisite in expanding Nigeria's participation in international trade and enhancing the country's export trade diversification in line with the present Federal Government policies in expanding and promoting non-oil exports in order to meet the economic growth and the debt repayment schedule. The study examines whether changes in forest export prices, domestic prices, domestic consumption quantity, national output quantity and foreign exchange rate have important effects on the volume of the commodities exported from Nigeria.

Previous empirical studies on determinants of export supply in developing countries (Bale and Lutz, 1981; Polland and Graham, 1985; Bhatia, 1992; Fedani, 1993; Tegene, 1990) suffer from methodological shortcomings such as the problem of spurious correlation often associated with non–stationary series, which in most cases invalidate their results and interpretations. Many related empirical studies have been conducted on the determinants of agricultural exports in Nigeria (Yusuf and Falusi, 1998/1999; Okoruwa *et al*, 2003; Okoh, 2004) using the error correction model (ECM) approach. However, most of these efforts have concentrated on non-forest products of the agricultural sector. These studies are therefore incapable of explaining the determinants of timber export. The major goal of this study is to address these neglected issues.

2. Methodology

2.1 Sources of Data

This data for this study were secondary in nature and covered 24 years from 1970-2003. These data were obtained from the Central Bank of Nigeria (CBN) Annual Statistical Bulletin (various issues), Food and Agriculture Organisation (FAO) Forest Products Yearbook (various issues) and the Oyo State Ministry of Agriculture, Natural Resources and Rural Development. Data were collected on official foreign exchange rate, export, domestic prices, domestic consumption, local output, world output and international prices of roundwood and sawnwood respectively.

2.2 Analytical Techniques

This study utilizes co-integration analysis also referred to as Error Correction Models (ECM). Co-integration has gained increasing popularity and importance in analysis that describes long run or equilibrium relationships (Tambi, 1998). An equilibrium relationship is said to exist between variables in a model when those variables are co-integrated. Two or more variables are said to be co-integrated when they co-move or move together at the same 'wavelength'. In other words, for co-integration to occur, the data series for each variable involved must exhibit similar statistical properties, that is, be integrated of the same order with evidence of some linear combination of the integrated series. A variable is integrated of the order I (0) when it is stationary in level form. Time series is stationary if its mean, variance and autocorrelation are constant over time. Fuller (1976) defined a stationary series as one that has its mean and variance constant over time and the value of the covariance between two time periods and not on the actual time at which the covariance is captured. If X_t is a non stationary series

$$X_t = \alpha + \beta X_{t-1} + e_t \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad ..(1)$$

Where α is a constant drift, β =1, and e_t is an error term. Most economic series tend to exhibit non-stationary stochastic process of the above form.

If e_t has zero mean, constant variance and zero covariance, then X_t is a random walk and is said to be integrated of order I(1). The series X_t is integrated because it is the sum of its base value X_o and the difference in X up to time t. If X_t is non-stationary, β is unity and is said to have a 'unit root'. Such a series' variances may become infinite and any stochastic shock may not return to a proper mean level; such a non-stationary series has no error correction representation (Engle and Granger 1987). A non-stationary series requires differencing to become stationary. X_t is integrated of order D_x or $X_t \sim I(D_x)$ if it is differenced D_x times to achieve stationarity. This can be achieved by using the Dickey-Fuller (DF) and Augmented Dickey Fuller (ADF) statistics (Engle and Granger, 1987). These tests are based on t-statistics on δ obtained from estimates of the following respective OLS regressions applied to each of the series:

$\Delta X_t = \alpha + \delta X_{t-1} + e_t$ (for DF test) .. .. (2)

$\Delta X_t = \alpha + \delta X_{t-1} + \sum \beta \Delta X_{t-1} I + e_t$ (for ADF test) .. .. .. (3)

Where the lag length K chosen for ADF ensures that e_t is empirical white noise (i.e stationary). Once the stationarity properties of the individual series are established, linear combinations of the integrated series are tested for co-integration. Co-integration is a test of stationarity of the residuals generated from running a static regression in levels of one or more of the regressor variables on the dependent variables.

ECM is accepted when the residuals from the linear combination of non-stationarity I(1) series are themselves stationary. The acceptance of ECM implies that the model is best specified in the first differences of its variables. Thus, the applications of the co-integration paradigm will guard against the loss of information from long term relationships in the first differences.

2.3 Empirical Estimation

Augmented Dickey-Fuller (ADF) was used to test for the stationarity of all the variables under study. This test is based on t-statistics and α_1 obtained from the estimates of static ordinary least square (OLS) applied to each of the series. In this study, the ADF test has been chosen because it captures additional dynamic left out by the DF (Dickey-Fuller) and ensures that the error term is white noise through the inclusion of additional lag length.

Johansen Tests for co-integration was also carried out using a linear deterministic trend in the VAR (Vector Autoregressive Representation) in order to know the number of co-integrating vectors. The variables are represented as follows:

$EXQR_t$ and $EXQS_t$ = Roundwood and Sawnwood export volumes (m^3) respectively;

OER_t = Official exchange rate (₦ to one $US dollar)

$LTOR_t$ and $LTOS_t$ = Local Roundwood and Sawnwood output (m^3) respectively

DCR_t and DCS_t = Domestic consumption of Roundwood and Sawnwood (m^3) respectively;

IPR_t and IPS_t = Roundwood and Sawnwood International prices (₦/m^3) respectively

WOR_t and WOS_t = World output (m^3) of Roundwood and Sawnwood respectively

$WEXR_t$ and $WEXS_t$ = World total export quantity (m^3) Roundwood and Sawnwood respectively

DPR_t and DPS_t = Domestic/producer price (₦) of Roundwood and Sawnwood respectively.

Eigen test was used to show if any of the eight variables under study are co-integrated and invariably to find out if a long-run relationship can be established among them. The general form of the export supply function is specified in double log form as follows:

$$LnEXQ_t = \beta_0 + \beta_1 LnOER_t + \beta_2 LnLTO_t + \beta_3 LnDC_t + \beta_4 LnIP_t + \beta_5 LnWO_t + \beta_6 LnWEX_t + \beta_7 LnDP_t + \beta_8 (ECM)_{t-1} + U_{it} \quad \ldots \quad (4)$$

Where U_{it} is the stochastic error term assumed to be independently and normally distributed with zero mean and constant variance. ECM_{t-1} is the error correction factor. When the coefficient of the ECM is statistically significant, it gives the credence to the existence of co-integration. Its magnitude defines the feedback mechanism amongst the co-integrating variables. However, the analyses concentrated on the long run parsimonious export determinant models which were obtained from the general long run error correction models by removing variables with low t-statistics and therefore not significant.

The standard supply theory indicates that the partial derivatives of supply of export with respects to export and domestic (local) prices of export goods are positive and negative respectively. Since DP_t is determined by the factors of supply and demand, the joint inclusion of DP_t and IP_t, LTO_t and DC_t, WEX_t and WO_t in equation (4) may lead to multicolinearity. To avoid the problem of multicolinearity, DP_t and IP_t are replaced by a relative price ratio index (DIP_t), which is the ratio of domestic or producer's price to international price; LTO_t and DC_t are replaced by a relative domestic output-consumption ratio LDO_t; and WEX_t and WO_t are replaced by a relative world export-output ratio, WEO_t, so that equation (4) now becomes:

$$LnEXQ_t = \beta_0 + \beta_1 LnOER_t + \beta_2 Ln\ LDOR_t + \beta_3 Ln\ DIP_t + \beta_4 Ln\ WEO_t + \beta_5 (ECM)_{t-1} + U_{it}$$

In terms of a priori expectation, a direct relationship is expected between the quantity of timber product exported (EXQ_t) and the following independent variables: domestic output-consumption ratio ($LDOR_t$), and official exchange rate (OER_t). On the other hand, the price ratio indexes (DIPt) and world export-output ratio (WEOt) are expected to have negative signs.

3. Results and Discussion

3.1 Stationarity Tests for the Variables

Table 1 presents the results of the augmented Dickey-Fuller (ADF) test statistics for unit root of all the variables in their level form and first differencing (in natural logarithm). The ADF test strongly supports the null hypothesis at the 1% level with a critical value of –3.6537 that all variables, excluding domestic consumption-output ratio of sawnwood and domestic-international price ratio of sawnwood, are 1(1) or non-stationary. There is, therefore, the need to difference the variables once to arrive at stationarity.

Table 1: Augmented Dickey-Fuller Unit root Tests of Variables at their Level Form and at First Differencing.

Variables	ADF Test Statistics (Level form)	Remark (level form)	ADF Test Statistics (at 1St Difference)	Remark (at 1St Difference)
$LnEXQR_t$	-1.9475	Non-stationary	-5.2059	Stationary
$LnEXQS_t$	1.2453	Non-stationary	-4.9055	Stationary
$LnOER_t$	0.6162	Non-stationary	-5.0925	Stationary
$LnLDOR_t$	2.7548	Non-stationary	-4.7823	Stationary
$LnLDOS_t$	-4.7456	Stationary	-	-
$LnDIPR_t$	-1.9085	Non-stationary	-6.0905	Stationary
$LnDIPS_t$	-5.1329	Stationary	-	-
$LnWEOR_t$	-1.6539	Non-stationary	-5.9039	Stationary
$LnWEOS_t$	0.06878	Non-stationary	-7.2305	Stationary

Critical value is –3.6537 at 99% confidence level. Significant at 1%.

Source: results printed out from EVIEW software.

All the variables became stationary at first differencing (see table 1 above) and therefore can be used to test for co-integration analysis.

3.2 Co-integration Tests

The results in table 2 for roundwood, the maximal Eigen values show that there is one co-integrating equation at both 1% and 5% critical levels. It therefore means that the null hypothesis (K = 0) of not having a co-integrating equation will be rejected and the alternative hypothesis of having one (K = 1) will be accepted. Table 3 below shows there is at most one co-integrating equation at 1 % critical level for sawnwood.

Table 2: Test for Number of Co-integrating Vectors of Roundwood using the Maximal Eigen Statistics.

Hypothesis		Eigen Value	Test Statistics	5% Critical value	1% Critical Value
Null	Alternative				
K = 0	K = 1	0.892774	71.45022**	33.46	38.77
K ≤ 1	K = 2	0.472712	20.48027	27.07	32.24
K ≤ 2	K = 3	0.370578	14.81448	20.97	25.52
K ≤ 3	K = 4	0.178824	6.304588	14.07	18.63
K ≤ 4	K = 5	0.057057	1.879970	3.76	6.65

*(**) denotes rejection of the null hypothesis at the 5%(1%) critical level.

Source: Computed from survey data.

Table 3: Test for the Number of Co-integrating Vectors of Sawnwood using the Maximal Eigen Statistics

Hypothesis Null	Alternative	Eigen Value	Test Statistics	5% Critical value	1% Critical Value
K = 0	K = 1	0.710518	39.66922**	33.46	38.77
K ≤ 1	K = 2	0.568408	26.88881	27.07	32.24
K ≤ 2	K = 3	0.421123	17.49330	20.97	25.52
K ≤ 3	K = 4	0.135684	4.666150	14.07	18.63
K ≤ 4	K = 5	0.022764	0.736874	3.76	6.65

*(**) denotes rejection of the null hypothesis at the 5%(1%) critical level.

Source: Computed from survey data.

3.3 The Long Run Restricted (Parsimonious) ECM for Roundwood.

Guided by the information from the stationarity test, the study proceeded to error correction representation of the model. The first step involved specifying an unrestricted model involving the dependent variables and their arguments differenced once, the lagged value of dependent variables and an error correction variable (ECM_{t-1}). At the second stage, the study utilized only the independent variables with significant influence on the dependent variables. These are reported in the write while the unrestricted model is available for inspection.

Table 4: Restricted Parameter Estimates for Roundwood

Variables	Coefficients	Standard Error	t-Statistics	Probabilities
C	-0.019***	0.083	-0.230	0.003
$\Delta lnEXQR_{t-1}$	0.627***	0.132	4.766	0.000
$\Delta lnLDOR_t$	-354.854***	76.871	-4.616	0.000
$\Delta lnLDOR_{t-1}$	249.078**	100.206	2.486	0.020
$\Delta lnDIPR_t$	-0.394***	0.128	-3.070	0.005
ECM_{t-1}	-1.110***	0.157	-7.083	0.000

** t value significant at 5% *** t values significant at 1%. R^2 = 0.752,

Adjusted R^2 = 0.705, F-statistics = 15.781(significant at 1%), Durbin-Watson statistics = 2.188.

Source: Computed from survey data.

The value 0.705 of coefficient of determination (R^2) shows that the independent variables explain 70.5% of the variations in the dependent variable (export quantity of roundwood). From table 4, the major determinants of roundwood export were found to be one-year lagged export quantity of roundwood ($EXQR_{t-1}$), domestic output-consumption ratio of roundwood ($LDOR_t$), one-year lagged domestic consumption-output ratio of roundwood ($LDOR_{t-1}$) and domestic-international price ratio ($DIPR_t$), and all are significant between 5% and 1% levels. One-year lagged export quantity of roundwood and one-year lagged domestic output-consumption ration are positively signed as expected, also the domestic-international price ratio of roundwood is negatively signed in accordance with apriori expectation while domestic consumption-output ratio of roundwood is not negatively signed as expected. The result shows that there is a positive relationship between the international price and the volume of roundwood exported. The one-year lagged export quantity of roundwood, positively signed as expected, has a direct relation with the quantity of roundwood to be exported. There is a positive relation between the one-year lagged domestic output-consumption ratio of roundwood and the quantity to be exported in the current year. The error correction term, ECM_{t-1}, was significant at 1% with a high feedback of 111.04%. It is also negatively signed, showing that the adjustment is in the right direction to restore the long run relationship. This confirms also that there is a strong relationship among volumes of roundwood exported, one-year lagged export quantity of roundwood, domestic output-consumption ratio of roundwood, one-year lagged domestic output-consumption ratio of roundwood and domestic-international price ratio.

3.4 The Long Run Restricted (Parsimonious) ECM for Sawnwood.

The final and parsimonious model is as presented in table 5.

Table 5: Restricted Parameter Estimates for Sawnwood

Variables	Coefficients	Standard Error	t-Statistics	Probabilities
C	8.822***	0.219	40.359	0.000
$\Delta lnOER_{t-1}$	3.107***	0.710	4.376	0.000
$\Delta lnLDOS_t$	-113.581***	34.000	-3.341	0.003
$\Delta lnLDOS_{t-1}$	-83.291***	26.747	-3.114	0.005
$\Delta lnWEOS_t$	7.098***	2.043	3.474	0.002
ECM_{t-1}	-1.772***	0.225	-7.892	0.000

** t value significant at 5% *** t values significant at 1%. R^2 = 0.712025,

Adjusted R^2 = 0.657, F-statistics = 12.857 (significant at 1%), Durbin-Watson statistics = 1.336.

Source: Computed from survey data.

The value 0.712 of the coefficient of determination (R^2) shows that the independent variables explain 71.2% of the variations in the dependent variable (export quantity of sawnwood). From the model, the major determinants of sawnwood exported include the lagged values of the official exchange rate (OER_{t-1}), domestic output-consumption ratio of sawnwood ($LDOS_t$), lagged domestic output-consumption ratio of sawnwood ($LDOS_{t-1}$) and world export-output ratio of the sawnwood ($WEOS_t$). All of these determinants are significant at 1%, and therefore strongly explain the variations in the export volumes of the sawnwood. The determinants are also of the expected signs in line with economic theory, excluding the world export-output ratio of the sawnwood. The error correction term, ECM_{t-1}, was significant at 1% with a high feedback of 193% in the value of sawnwood exported. Thus, there is high speed of adjustment in restoring the long run relationship in the right direction. This confirms also that there is a strong relationship between volume of sawnwood exported and its major determinants, that is, the lagged values of the official exchange rate, domestic output-consumption ratio of sawnwood, lagged domestic output-consumption ratio of sawnwood and world export-output ratio of the sawnwood.

4. Conclusion and Recommendations

Roundwood and sawnwood exports have contributed immensely to the foreign exchange earnings in Nigeria. However, major fluctuations in export earnings have raised concern about the country's future growth potential and debt repayment, as well as in expanding non-oil export commodities. The coefficients of the determinants of roundwood export quantities (excluding domestic output-consumption ratio of roundwood) were found to have the expected signs that are in conformity with economic theory. The study also proved that the most important factors determining the quantities of export of sawnwood from Nigeria are the lagged values of the official exchange rate, domestic consumption-output ratio of sawnwood, lagged domestic consumption-output ratio of sawnwood and world export-output ratio of the sawnwood. These determinants (excluding the world export-output ratio of the sawnwood) are also of the expected signs in line with economic theory.

The study revealed that there may be other factors influencing the quantities of roundwood and sawnwood exported from Nigeria which were not included in the study as indicated by the coefficients of determination of the two timber products. 75.22% of the variations in roundwood were captured by the variables used, and therefore living approximately 24.88% yet to be captured, while that of the sawnwood variables captured about 71.20% of the variations in the quantities of sawnwood exported, leaving 28.80% yet to be captured.

External sector has a key role to play in the growth and development of the Nigerian economy in terms of expanding non-oil exports, as well as, in her debt servicing as shown by the results of the study. To meet the growth, development and debt servicing agreement, the following policies are recommended in other to boost the exports of timber in Nigeria.

Exportation of value added Wood (sawnwood): The results of the trend analysis showed that from the early 1990s less of the roundwoods were exported compared to the ever increasing export quantities of sawnwoods. This means more of the roundwoods are converted to sawnwoods by the additions of some values. This made more sawnwoods to be available for the domestic and export demands. This is very much in line with the value-added export orientation by the government. Therefore more of the roundwoods should be converted to sawnwoods for more foreign exchange.

Need for Wood Export Quality Control Body: The domestic-international price ratio index for the roundwood was seen to be one of the factors determining export quantities in the study, and was found to have a negative sign. This means that the higher the price index ratio (and consequently, lower international price), the lower the quantity of roundwood exported, that is, higher international prices favour higher export quantities of the two timber products, but the reverse was found out to be the case. This was not caused by lower output quantities, but as a result of exporting roundwood that were of lower quality which of course did not attract patronage at the international market. There is, therefore, the need for a timber based export quality control body to certify that only roundwoods of international standard are exported in order to gain the confidence and patronage of the international buyers of sawnwood at the international market.

Need for Stable Macroeconomic Environment: The federal government should endeavour to achieve and maintain a stable macroeconomic environment, especially in exchange rate stability in other to encourage people into exporting of woods since they can forecast and plan ahead by the virtue of a stable economy. No man wants to invest in an economy whose macroeconomic policies are not stable, and therefore economically unpredictable.

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APPENDIX

Appendix 1: Round wood Average Output and Export Volumes, and their respective Growth rates

Year	Average Output Quantity ('million M^3)	Average Output Growth Rate (%)	Average Export Quantity ('million M^3)	Average Export Growth Rate (%)
1970 - 1975	42.403	-	0.229	-
1976 - 1980	46.499	9.66	0.013	-94.02
1981 - 1985	54.486	17.18	0.059	354.83
1986 - 1990	58.430	7.24	0.059	0.00
1991 - 1995	62.445	6.87	0.007	-86.68
1996 - 2000	67.757	8.51	0.010	28.42
2001 - 2003	69.488	2.56	0.004	-52.18

Source: Computed from FAO Yearbook of Forest Products of various issues.

Appendix 2: Sawnwood Average Output and Export Volumes and their respective Growth Rates.

Year	Average Output Quantity ('million M^3)	Average Output Growth Rate (%)	Average Export Quantity ('000 M^3)	Average Export Growth Rate (%)
1970 - 1975	0.703	-	32.516	-
1976 - 1980	1.674	138.12	1.480	-95.45
1981 - 1985	2.753	64.43	0.980	-33.78
1986 - 1990	2.886	4.84	9.855	905.59
1991 - 1995	2.607	-9.67	33.396	238.89
1996 - 2000	2.036	-21.91	47.034	40.84
2001 - 2003	2.000	-1.75	36.800	-21.76

Source: Computed from FAO Yearbook of Forest Products of various issues.