SUPPLY RESPONSE OF RUBBER FARMERS IN NIGERIA: AN APPLICATION OF VECTOR ERROR CORRECTION MODEL

[1]C.S. Mesike, [2]R.N. Okoh, and [2]O.E. Inoni

[1]Rubber Research Institute of Nigeria, PMB 1049, Benin City, Edo State, Nigeria.
[2]Department of Agricultural Economics and Extension, Delta State University, Asaba Campus, Nigeria
sammesike@yahoo.ca

Abstract: The supply response of rubber farmers to prices and other factors in Nigeria was analyze using co-integration and vector error correction technique. The analysis was carried out on time series data collected from 1970 to 2008. The data where however tested for their time series characteristics using ADF tests. Preliminary analysis suggested that estimations based on their levels might be spurious as the results indicated that all the variables in the model were not stationary at their levels. Further results indicated that producers prices and the structural break significantly affected the supply of rubber. Response of rubber farmers to price were low with an estimated elasticity of 0.373 in the short-run and 0.204 in the long-run due to price sustainability and the emergence of other supply determinants indicating significant production adjustments based on expected prices. Policy efforts in promoting sustainable marketing outlets and promoting high value and high quality products for export were suggested in understanding farmers' responses to incentive changes. [Journal of American Science 2010;6(9):52-56]. (ISSN: 1545-1003).

Key words: supply response, vector error correction, rubber, price elasticities, Nigeria

1. Introduction

Since the late 1980s, international financial institutions supported the introduction of Structural Adjustment Programme (SAP) in Nigeria to correct market and price distortions. The SAP involved a policy measures towards a more market-friendly trading system and the dissolution of commodity marketing boards as well as eliminating the heavy dependence on crude oil export and import of consumer and producer goods (Ihimodu, 1993). The SAP on one hand had short run positive effect on farmers producing the traditional agricultural commodities such as tea, coffee, cocoa and rubber due to the income and price elasticity coefficients for these commodities. On the other hand, SAP opened up the export of new commodities that become popularly demanded internationally. According to Olomola and Akande (1990), commodities marketing board served as a great disincentive to farmers both in production and replanting. As reported by several studies, the commodity boards represented agencies for taxation, as the producer prices paid to the farmers were well below world prices (Idachaba, 1990; Akanji and Ukeje, 1995).

Liberalization of both domestic and international trade of goods and services, liberalizations of the relation between owners and tenants in agriculture land, removing government controls on prices, cropping areas, cropping patterns, crop procurement delivery, quotas, eliminatory subsidies on farm inputs, removing government constraints on private sector, liberalization of the interest rate and liberalization of the exchange rate were issued.

However, despite efforts to improve on commodity trade, Nigeria agriculture is currently showing little signs of being able to compete in the liberalized economy. Today the producers of traditional agricultural commodities in Nigeria face the world market directly. They reap profits when prices are good but absorb shocks and suffer losses when prices fall. Consequently the producer's price of these commodities has become unstable and this create dis-incentive for production thus making output and exports to suffer (Mesike et al 2008). This could have negative implications for the agricultural industry and for the national income. Consequently, the prices at which rubber and other cash crops farmers in Nigeria were able to sell their produce to a large extent now depend on how they respond to both local and global demand.

As part of the efforts being made to restore Nigeria's Agriculture to its past eminent position in the economy, former Nigerian President (General Olusegun Obasonjo rtd.) had at various times organized fora where he met with relevant stakeholders in food crops, tree crops and Livestock industry respectively. The fora aimed at identifying the peculiar problems confronting each industry and to chart the way forward. The various Presidential Committees established have produced blueprints to boost production and achieve self sufficiency within the shortest possible time and also generate surplus for export.

In order to sustain and improve on the performance of rubber production, the President, Federal Republic of Nigeria launched a special programme tagged "Presidential Initiative on Rubber" in Rubber Research Institute of Nigeria in 2006 to promote increase in both local production and utilization of rubber to the point where Nigeria can export and have enough for domestic use, generate rural employment, increase farmers income and standard of living. The recent Presidential initiatives on rubber have raised the hope of farmers to some extent that many farmers have gone back to their abandoned farm. Within the short period of operations, the Presidential Initiative has made remarkable achievements. Notable among these achievements is the planting and rehabilitation of old plantations and setting up of new ones, increase in production, sensitization and training of farmers, sensitization for increase in local consumption and exports, and renewed efforts in research. It is on the strength of this issues that the study aims at estimating the supply response of cocoa and rubber farmers in Nigeria to incentive changes

2. Materials and Method

2.1 Data Source

The data for this study were obtained from secondary sources including the local and international agencies. The local agencies included the Central Bank of Nigeria (CBN) (data computed from CBN Statistical Bulletin - 2008, various issues of CBN Economic and Financial Review and CBN Annual Report and Statement of Account) and the National Bureau of Statistics (NBS – various issues). The Food and Agriculture Organisation (FAO-various issues) and the International Financial Statistics (IFS-2009) served as the main international agencies. The empirical analysis covers the period from 1970 to 2008.

2.2 Analytical Techniques

Long-run supply response is estimated using variables indicated in equation 1

$$Yt = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 P_{1t-1} + \alpha_3 P_{2t-1} + \alpha_4 ER_{t-I} + \alpha_5 T_t + \alpha_6 TD_t + \varepsilon_t \quad (1)$$

Where:

- Y_t is the dependent variable representing the output at time t
- Y_{t-1} is the independent variable representing the output at time t-1
- P_{1t-1} represents a vector of producers' prices at time t-1
- P_{2t-1} represents a vector of export price at time t-1
- ER_{t-1} represents the real effective exchange rate at time t-1
- T_t stands for time trend.
- TD_t stand for structural breaks. The value of TD_t was obtained as follow:

  $TD_t = 1$ if $T > 1985$, and 0 otherwise

The study employed Johansen maximum likelihood procedure of cointegration which results in the Vector Error Correction Model (VECM) to analyze the data. The estimation procedure was used to overcome the problems of spurious correlation often associated with non-stationary time-series data. Furthermore, the procedure enables the analyst to generate long-run relationships (Engle and Granger, 1987; Hendry, 1986; Johansen, 1988; Johansen and Juselius, 1990; Goodwin and Schroeder, 1991; Hallam *et al.*, 1994). In this method, a preliminary analysis is carried out first to assess the order of integration of the data series using the Augmented Dickey- Fuller (ADF) test to examine each of the variables for the presence of unit root (an indication of non-stationarity), since it can handle both first order as well as higher order auto-regressive processes, by including the first difference in lags in the test in such a way that the error term is distributed as white noise. The ADF test for unit roots requires the following regression

$$\Delta X_t = \alpha_o + \delta X_{t-1} + \sum \beta \Delta X_{t-1} I + e_t \quad (2)$$

Where,

ΔX_t = is the first difference of X_t

δ= test coeficient

e_t = white noise

The decision rule states that the t-statistics on the coefficient of the variable δ, which is expected to be negative, must be significantly different from the critical values for a given sample size, if the null hypothesis is to be rejected. The null hypothesis is that the variable of interest is non-stationary [i.e it is integrated of order one I (1)]. If this is accepted, the series is non-stationary. In this case differencing the series will yield a stationary series, that is, the process is difference stationary. A series is said to be integrated of order d if it becomes stationary after differencing d times and this is written as I(d). A stationary series is an I(0) series. Once the series are found to be non-stationary then there should exist a linear combination of these variables, which is integrated of order one or non-stationary. The next logical test is to test for cointegration.

The concept of cointegration states that if there is a long-run relationship between two variables then the deviation from the long run equilibrium path should be bounded, and if this is the case then the variables is cointegrated. Two conditions must be met for variables to be cointegrated. First, the series must have the same order of integration. Second, there must be some linear combination (r) of

variables, which must be, at most, of order one less than the number of individual variables (n), that is r = n-1 (Townsend and Thirtle, 1997). If r = n, then the series are stationary and cointegrated. If deviation from the long-run equilibrium path is bounded or co-integration is confirmed, Engle and Granger (1987) show that the variables can be represented in a dynamic error correction framework. Therefore in this study, like similar studies elsewhere, supply response is modeled in two stages. First, a static co-integrating regression giving in equation 1 is estimated and tests for co-integration are conducted. Second, if the null for no co-integration is rejected, the lagged residual from the co-integrating regression are imposed as the error correction term in a vector error correction model (VECM). A VECM model is shown below:

$$\Delta Yt = \beta_0 + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta P_{1t-1} + \beta_3 \Delta P_{2t-1} + \beta_4 \Delta ER_{t-1} + \beta_5 \Delta T_t + \beta_6 \Delta TD_t - \lambda (Yt - \alpha_0 - \alpha_1 Y_{t-1} - \alpha_2 P_{1t-1} - \alpha_3 P_{2t-1} - \alpha_4 ER_{t-I} - \alpha_5 T_t - \alpha_6 TDt) + \omega_t \quad (3)$$

All the variables are as earlier defined. Where Δ represents first difference operator while β_1 to β_6 are short-run coefficients, λ is error correction mechanism that measure the speed of adjustment from short-run disequilibria to long-run steady state equilibrium and ω_t is the stochastic error term assumed to be independently and normally distributed with zero mean and constant variance

3. Results and Discussion

3.1 Stationarity tests

Table 1 presents the results of the Augmented Dickey-Fuller (ADF) classes of unit root tests. The tests were applied to each variable over the period of 1970-2008 without a time trend at the variables level and at their first difference. The ADF tests strongly support the null hypothesis that all the variables were not stationary at their level. This indicates that the variable are I(1) and any attempt to specify the dynamic function of the variable in the level of the series will be inappropriate and may lead to problems of spurious regression. In essence, the econometric results of the model in that level of series may not be ideal for policy making, Yusuf and Falusi (1999) and such results can not be used for prediction in the long-run.

Table 1 Augmented Dickey-Fuller (ADF) unit root tests

Y_{t-1}	-0.9802	-2.9411	-3.6156	0	0.7506
P_{1t-1}	0.4026	-2.9434	-3.6210	1	0.9804
P_{2t-1}	-0.7614	-2.9434	-3.6156	0	0.8185
ER_{t-1}	-0.0319	-2.9411	-3.6156	0	0.9495
ΔY_{t-1}	-5.1763*	-2.9434	-3.6210	0	0.0001
ΔP_{1t-1}	-3.3977**	-2.9434	-3.6210	0	0.0174
ΔP_{2t-1}	-6.3920*	-2.9434	-3.6210	0	0.0000
ΔER_{t-1}	-6.2138*	-2.9434	-3.6210	0	0.0000

*Significant at 1% **Significant at 5% Δ = first difference
Critical value of ADF tests are based on Mackinnon (1996) one sided p-values.
Lag length selection was automatic based on E-views 5.0 Schwarz information

Table 2 Johansen Cointegration Test of Supply of Rubber

r=0*	None	54.36	47.86	0.010	27.83	27.58	0.047
r=1	At most 1	26.53	29.80	0.114	17.97	21.13	0.131
r=2	At most 2	8.56	15.49	0.408	8.48	14.26	0.332
r=3	At most 3	0.08	3.84	0.776	0.08	3.84	0.776

* Denotes rejection of the Null hypothesis at the 5% level

3.2 Cointegration test

Table 2 shows the summary results of the Johansen's Maximum Likelihood co-integration test. The test relations were estimated with intercept and linear deterministic trend. From the results, it is evident that both the trace test and maximum Eigen value test indicate one co-integrating equation as the null hypothesis of r = 0 is rejected. Thus, there is a unique long-run equilibrium relationship between the variable concerned. Where only one co-integrating equation exists, its parameters can be interpreted as estimate of long-run cointegrating relationship between the variables concerned. (Hallam and Zanoli, 1993). The cointegration coefficients normalize on rubber supply are presented as long-run estimates in Table 3.

3.3 Vector Error Correction Estimate of Rubber

The existence of co-integration among the dependent variable and their fundamentals

necessitated the specification of VECM for rubber as well as its estimation in this study. Table 3 shows the results of the VECM estimates for supply response of rubber to incentive changes in Nigeria. Both the short-run and long-run estimates as well as diagnostic statistics are presented. The model was chosen on the basis of the following criteria: data coherence, parameter consistency with theory and goodness of fit.

In Table 3, the result showed that planned supply of rubber is affected positively by the producer's price and structural break in the short-run. The producer's price was significant at 5 percent while the structural break was significant at 1 percent. The positive significant of the producers price implies that there is need to increase the producer prices to match world prices so as to encourage increased output. The positive significant coefficient of the structural breaks indicates the better effect of deregulation on rubber output. In other words the abolishing of cocoa marketing boards actually favored the farmers by increasing cocoa output in response to improving the producer and export prices. At the long-run, the supply of rubber is positively affected by the producer's price at 10 percent and structural break at 1 percent.

The error correction coefficient of (-0.5572), which measures the speed of adjustment towards long-run equilibrium carries the expected negative sign and it is very significant at the 1% level. The coefficient indicates a feedback of about 55.72 percent of the previous year's disequilibrium from the long-run values of the independent variables. The error correction coefficient indicates that more than 55 percent of the adjustment towards long-run equilibrium for supply of rubber is completed in one period. The result also shows that the coefficient of determination (R^2) of supply of rubber is 0.4834, thus the independent variables explain 48.34 percent of the variations in the dependent variable.

The price elasticity of rubber in the short-run is 0.3727 and it is significant at 5% level while in the long-run, the price elasticity is 0.2036 which is significant at 10% level. The result of the price elasticity of rubber show that 5% increase in the producer's price of rubber lead 3.73% increase in the supply of rubber in the short-run while 10 percent increase would raise the supply of rubber by 2.04 percent in the long-run. Low short-run and long-run elasticities of supply indicate that growers of rubber in Nigeria do not make significant short and long-run production adjustments in response to changes in expected prices. This may be due to price sustainability over time and the emergence of other supply determinants which are more relevant than prices. Reliable market outlets are among these factors.

Table 3 Short-run and Long-run VECM Results of Supply of Rubber in Nigeria

Long-run			
Variable	Coefficient	Standard error	Test statistic
Constant	-46518.68		
Y_t	1.0000		
P_{1t}	0.2036***	0.1321	1.5609
P_{2t}	-0.1203	0.1321	-0.9105
ER_t	211.3799	315.572	0.6698
TDt	75948.54*	8501.80	8.9332
Short-run			
Constant	118.9327	1089.79	0.1091
Y_{t-1}	0.2373***	0.1390	1.7071
P_{1t-1}	0.3727**	0.1878	1.9849
P_{2t-1}	-0.1214	0.0932	-1.3023
ER_{t-1}	-13.2102	176.996	-0.0746
TD_{t-1}	43997.94*	13151.6	3.3454
ECM(-1)	-0.5572*	0.1008	-5.5279
* Significant at 1%		F- value = 8.12*	
** Significant at 5%		SC = 21.93	
*** Significant at 10%			
Adjusted R^2 = 0.4834			

4. Conclusion and Policy Implications

Previous time series studies of agricultural supply response in Nigeria use classical regression and Nerlovian which have well-known restrictive implications for dynamic adjustment. The results from these studies may be spurious because economic series tend to be non-stationary. This paper re-examines the supply response of rubber using the

co-integration and vector error correction analysis which incorporates both a more general dynamic structure than Nerlovian models and overcomes the potential problem of spurious regression. Results show that rubber farmers adjust to changes in price and structural break. Short-run and long-run price elasticities were low suggesting price sustainability and the emergence of other supply determinants indicating significant production adjustments based on expected prices. From the findings, efforts aimed at promoting sustainable marketing outlets and promoting high value and high quality products for export is pertinent in understanding farmers' responses to prices.

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Correspondence to:
Mesike Chinye Samuel,
Rubber Research Institute of Nigeria,
PMB 1049, Benin City, Edo State, Nigeria
GSM: +2348034215563
Email: sammesike@yahoo.ca

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