ESTIMATION OF FARMERS' RESPONSE TO PRICE DYNAMICS IN PARTIAL ADJUSTED AUTOREGRESSIVE AND DISTRIBUTIVE LAGGED MODELS: AN APPLICATION TO RUBBER PRODUCTION IN NIGERIA

Abiola M. O. and Ada-Okungbowa C. I.
matola31@yahoo.com
Department of Agricultural Economics and Extension Services, University of Benin, Nigeria

Abstract
The study examined the response of rubber output to price dynamics in Nigeria. Secondary data of rubber output in hectares and price for a period of forty four years (1960-2004) from Central Bank of Nigeria and National Bureau of statistics were used for the study. Inferential statistics; partial adjusted autoregressive and distributive lagged models of regression were applied to the secondary data obtained. The result of partial adjusted autoregressive model indicates that the one period lagged producer price had a short run elasticity of 0.043 and it is significantly different from zero with observed long run elasticity of 6.7169. The adjusted lagged coefficient had increasing effect on hectarage of rubber in the period under review. A stationary situation was observed given that DFr (tau) calculated (3.818) was greater than DF r (tau) statistics of -2.620. Equilibrium exists but the rate of adjustment from both directions is slow. The distributive lagged model short run elasticity of 0.003 and 0.007 for the two lagged periods indicates that previous prices had increasing effect on rubber output. The study concludes that price policies are effective tools for obtaining the desire level of output in rubber production in Nigeria.

Keywords: Rubber Price, Autoregressive model, Partial adjustment, Supply response

Introduction

Production in the current period is assumed to be determined by decisions made in previous periods. It is generally believed that current output reflects a production decision made by producers in the previous periods (Jhingan, 2003). Therefore, it is believed that a rise in current price as incentive to farmers will result in an increase in future hectarage and ultimately output. In most cases in agrarian world it is not so. There is the belief that the bases for increase in agricultural production are technology, fertilizer, herbicides, credit, and informed variety of the cultivar in question. The promoter of price as the basis for growth indicates that a fall in current year output below demand will jack-up the current price and farmers will respond by increasing hectarage, hoping that the price that will be established during the next period will be equal to the price during the previous year (Abiola and Izekor, 2010).

Expectations about future conditions have important influence on current price. When there is crop failure arising from risk and uncertainty that characterized agricultural production, the supply will be reduced and with a static demand many will shoot up price in current disadvantage period.

Price has a definite effect on national income. A fluctuation in price creates instability and it is disincentive to producers and consequently level of exports, the rubber industry and the national income. In the early 1960s Nigeria is the largest producer of natural rubber in Africa (Nosa, 2008). Currently natural rubber is still being exported but it is faced with a dwindling performance in term of aggregate output and export quantities. Nigeria fell to the fourth position in Africa in 2001 with a 14% share of Africa annual output and 0.7% share of world output. There is a rising decrease in rubber output and export in Nigeria with a fluctuating market price.

The unusual question is, what is the effect of changes in price on rubber output and hectarge, will a rise in rubber price leads to an increase in farm size and ultimately rubber output, will a dwindling price provoked voluntary withdrawal from rubber production? What is the short and long run effect of price changes on equilibrium? This study provides answers to this research questions. In Nigeria, the federal government agricultural pricing policy objective is to ensure stable and attractive producer price for agricultural commodities in order to encourage farmers to produce more. Nigeria government has always allowed the market forces to determine the internal food prices without intervention (Nosa, 2008). The objective of this study is to estimate the response of rubber output to price changes in Nigeria using a secondary data. Studies on response of rubber to price incentives are very scarce. Study on the impact of changes in price on output is very important because supply response is used as tool to evaluate the effectiveness of price policies in the allocation of farmers resources and estimates of supply responsiveness will provide useful guidelines for formulating economic policy (Hug and Arshad, 2010; BBS, 2008).

Methodology

Area of Study and Source of Data

The study is a macro level analysis of Nigeria rubber production. Nigeria as a country gained independence in 1960 from Great Britain and it has thirty- six components known as state including the federal capital territory. It has a total land area of 923,773 square kilometers and population density of 95.8 people per square kilometers (Census, 1991). The study made use of secondary data obtained from Central Bank of Nigeria, Food and Agriculture Organization, International Financial Statistics (IFS) publication and National Bureau of Statistics. The key data element collected from the secondary sources (include prices, hectarage, and output of rubber for a period of forty four years. (1960-2004). The crop of interest is rubber mainly cultivated as cash crop for latex and other secondary uses. The study focused mainly on latex which is the primary purpose of cultivation.

Analytical Technique:

Studies on dynamic econometric analysis relied so much on the work made available by Nerlove fifty years ago (Hug & Arshard, 2010).Nerlove model in 1958 captured the dynamics of agriculture by incorporating price expectations and adjustment. Costs studies preceding Marc Nerlove includes Ezekiels paper of 1938, which emphasized the famous „Cobweb theorem" and the issue of self-perpetuating fluctuations of the price of some agricultural commodities observed by Timbergen (1930) Ricci (1930) and Kaldor (1934). Nerlove (1958) indicated that the desire output is function of price expectation P_t^e so that the supply function can be presented as:

$$Y_t = \propto_0 + \propto_1 X_t + U_t -------------- (1)$$

The expected price is not directly observable.

Therefore the desired planned output is a function of expected income or price from producers. Nerlove postulated the partial adjustment or stock adjustment hypothesis that

$Y_t - Y_{t-1} = \delta(Y_t - Y_{t-1})$ ------------------------- (2)
Where $0 < \delta \leq 1$ is known as coefficient of adjustment and
$Y_t - Y_{t-1}$ = Actual change
$(Y_t - Y_{t\ 1})$ = desire change
Nerlove like in partial adjustment model postulated in adaptive expectation model that
$P_t^e - P_{t-1}^e = \delta(P_{t-1} - P_{t-1}^e)$ ------------------------- (3)

Where P_t^e = Expected price of the product in Current year.
P_{t-1}^e = Expected price in previous year
P_{t-1} = last year actual price
δ = Adoptive expectation parameter
Partial Adjustment Model (PAM) can be written as
$Y_t = \delta Y + (1-\delta)Y_{t-1}$ ------ _ ------------- (4)

and by substituting equation one into four
$Y_t = \delta(\propto_0 + \propto_1 X_t + U_t + (1-\delta)Y_{t-1}$ --- (5)
$Y_t = \delta \propto_0 + \delta \propto_1 X_t + (1-\delta)Y_{t-1} + \delta U_t$

$Y_t = \delta \propto_0 + \delta \propto_1 X_t + (1-\delta)Y_{t-1} + \delta U_t$ --- (6)

This is known as partial adjustment model

The short run elasticity is given by $\delta \propto_1, \delta \propto_0$ while the long rum elasticity is given by dividing each coefficient by adjustment parameter.

Therefore it can be postulated that the desired output is a function of expected price and other variables.
The reduce form of equation 6 equals
$Y_t = \propto_0 + \propto_1 X_t + \propto_2 Y_{t-1} + U_t$

Including other variable gives the auto regressive partial adjustment model given as
$Y_t = \propto_0 + \propto_1 X_{t1} + \propto_2 X_{t2} + \propto_3 X_{t3} + \propto_5 Y_{t-1} + U_t$
(7) Where
$\propto_0 = \delta \propto_0, \propto_1 = \delta \propto_1, U_t = \delta U_t, \propto_5 = (1-\propto)$
Y_t = Hectarage of rubber
X_{t1} = Producer price of rubber
X_{t2} = World price of rubber
X_{t3} = Output of rubber
Y_{t-1} = Lagged Hectarage
U_t = Random variable
Hypothesis $H_0 = \delta = 0$ $H_0 = \delta \neq 0$
Where output in the current year is specified as a function lagged price for two periods.
In the distributive lagged model (DLM) of output which is specified as function of price
$Qt = \beta + \beta_1 X_{(t)} + \beta_2 X_{(t-1)} + \beta_3 X_{t-2} + U_t$
Where
Q_t = Output of rubber in the current year
X_t = Producer Price of rubber in current year
X_{t-1} = Producer Price of rubber lagged by one year
X_{t-2} = Producer Price of rubber lagged by two years and

U_t = is random variable.

The Partial Adjusted Model (PAM) is one of the ways of rationalizing the Koyck autoregressive model (Gujarati, 2005). Marc Nerlove in 1958 developed the PAM type of autoregressive regression model. In this situation he assumes that there is an equilibrium, optimal desire or long run relationship between dependent and explanatory variable in a dynamic scenario. The desire level of output Y* is specified as a function of independent variables; world price WPR_t producer price PPR_t and output OUP_t stated algebraically as:

$Y^*_t = \beta_0 + \beta_1 PPR_t + \beta_2 WPP_t + \beta_3 OUP_t + U_t$
Where $Y_t - Y_{t-1} = (Y^*_t - Y_{t-1})$

Where $Y_t - Y_{t-1}$ = equal the actual change and ($Y^*_t - Y_{t-1}$)($Y^*_t - Y_{t-1}$) is the desire change where $0 < \delta < 1$s the coefficient of adjustment and equation the above postulate that change in output at a given time period is some fraction of the desire change for the period. If δ = 1 implies actual output equals desire output if $\delta = 0$ implies that there is no change in the two periods.

Therefore $Y_t = Y^*_L + (1- \ ) Y_{t-1}$
If Y_{t-1} coefficient equals zero it implies there is non-stationary situation. But when there is random walk with or without drift, a non stationary situation model as

$Y_t = \quad Y_{t-1} + U_t$
$Y_t - Y_{t-1} = \Delta Y_t$
and δ is drift parameter indicating that Y_t drifts upward or downward depending on being positive or negative. However, there is a time lag of more than three years before output arising from an increase in farm size which implies that current price cannot increase the next year output. Therefore to determine the response of rubber on annual basis hectarage is substituted instead of output as dependent variable because farmers response to current price cannot be determine in the following season of production Therefore the estimated model which as equivalent of equation (7) is given as

$Y_t = HECT_t = \beta_0 += \beta_1 PPR_t += \beta_2 WPR_t + (1- \delta) Y_{t-1} + U_t$ - - (9)
and the reduce form of the model is given as
$HECT_t = \beta_0 + \beta_1 PPR_t + \beta_2 WPR_t + \beta_3 OUP_t + (\beta_4) HCT_{t-1} + \beta_5 PPR_{t-1} + \beta_6 WPR_{t-1} + \beta_7 OUP_{t-1} + U_t$

Where
$HECT_t$ = Hectarage of rubber in the current
year $HECT_{t-1}$ = Hectarage of rubber in previous
year PPR_t = Current producer price of rubber
PPR_{t-1} = One year lagged producer price of rubber
WPR_t = Current world producer price of rubber
WPR_{t-1} = One year lagged world producer price of rubber
OUP_t = Current Output of rubber
OUP_{t-1} = One year lagged Output of rubber
$\beta_0 - \beta_4$ = Parameters to be estimated

U_t = Random variable

The distributive lagged model (DLM) which is equivalent of equation (8) is expressed algebraically as:

$$OUP_t = \beta \quad \beta_1 PPR_t + \beta_2 PPR_{t-1} + \beta_3 PPR_{t-2} + U_t$$

Where
OUP_t = Current Output of rubber
PPR_t = Current Producer price of Rubber
PPR_{t-1} = One year lagged Producer price of Rubber
PPR_{t-2} = Producer Price lagged by two year
β_0 - β_3 are parameters of distributive lagged models.

Result and Discussion

Rubber Response to Price Incentive in Partial Adjustment Autoregressive Model:
The study examines the annual hectarage of rubber in relation to world and producer prices of rubber for a period of forty four years in autoregressive model. A priori real output, or hectarage is expected to be positively related to price. The relationship between output of rubber and price should indicate a supply scenario. Actually hectarage was used in proxy for output because of gestation period of rubber which disallows the annual effect of price change on rubber output. The positive association between current world price and rubber hectarage is expected. The current producer price had a negative influence on current hectarage but previous year price had a positive relationship with current rubber hectarage. Actually, it is previous price that influence current hectarage which is agreement with economic theory. About 94% of variation in hectarage was captured by the variables included in the model as indicated by R^2 value of 0.949 and adjusted R^2 value of 0.941. The estimated short run price elasticity of supply for the lagged producer price had the correct sign and was statistically significant. A unit change in previous price of rubber result in 0.043 increases in present rubber hectarage. Current price had a negative influence on output. Actually, price of rubber output in current season may not influence hectarage or output which probably account for wrong sign. The relationship was however significant. Previous and current world producer price had no significant effect on changes in hectarage during the period under review. Giving the correct sign and the fact that producer price for current year and a year lagged price had a statistically significant relationship indicates that price is a veritable tool as policy instrument to influence rubber output in Nigeria, The coefficient of adjustment was 0.006 indicating a very slow rate of adjustment which shows that only about 1% of the discrepancy between the desire price and real change in hectarage occurs in a year. The long run elasticity of producer price is 6.11692 which is greater than the short run elasticity. The outcome is in agreement economic theory. In the model some of the variable were not statistically significant but the desirable aspect of the model is that the long run and short run impact of previous price on current hectare was very significant showing that price as incentive can lead to desire growth in rubber output. Also the coefficient of partial adjustment in the model known as is less than one indicating a stationary situation and a time series that is integrated of order zero (Table 1)

Output was specified as a function of current price and lagged price of rubber for two periods. Price had a negative influence on output in the current year with short run price elasticity of -0.008. The negative effect of price is due to fact that a good current price cannot influence current output because of gestation period time. The short run elasticity was 0.003 and 0.007 for two lagged periods indicating that price had an increasing effect on output. Although estimates for the three periods were not significant but the outcome is excellent indicating that a good price today will produce a rise in yield in two or three years to come. Therefore price is a veritable tool or incentive to increase natural rubber output. Also, the outcome indicates that effort should be made to sustain price because a fall in price today may produce a dwindling output in the nearest future. Therefore government has a role to play by stabling price to ensure a stable output in rubber market given a long run impact of 0.009438 for every unit change in price. The outcome here indicates that about 3% of changes in price will be felt in the second year while about 8% will be felt in the third year. The R square value of 0.54053 indicates that variables excluded from the model and unexplained variation captured about 35% of the unexplained variation in output. Given that Dickey-Fuller r (tau) calculated of 3.8315523 is greater than the theoretical value of -3.654548 for the mean value of output but the theoretical values were greater than calculated values for the current and the two period estimates indicating that estimated price elasticity's were not significantly different from zero.

Conclusion and Recommendation

It is established in this study that price policy is a veritable tool for securing desirable level of output of rubber in Nigeria. Price has increasing effect on output of rubber and a stationary situation was observed indicating that equilibrium exist but the rate of adjustment from both direction is very slow. Government is encouraged to ensure stable price to avoid slippery down ward direction in future rubber output. Effort should be geared toward the creation of commodity boards in other to provide avenue for interventions in term of price control that will stabilized price for farmers in disadvantage period so that today bad price will not create shortage of tomorrow rubber output. Demand driven production should be encouraged to spark off industrialization of rubber sector through good price incentives

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Table 1: Estimate of rubber responses to changes in price in Partial Adjusted Auto-regressive model.

Variable	Coefficient	Std.Error	t-Statistic	Prob.
Constant	0.00800	0.000420	10.65200	0.0000
LNHECRUBB(-1)	1.00600	0.004299	234.0906	0.0000
LNWPR(-1)	-0.00800	0.007564	-1.128588	0.2663
LNPPR(-1)	0.04300	0.011329	3.818214	0.0005
LNOUP(-1)	-0.00050	0.022094	-0.026076	0.9793
LNWPR	0.000733	0.007395	0.099092	0.9216
LNPPR	-0.032953	0.011044	-2.983802	0.0050
LNOUP	-0.021434	0.022126	-0.968716	0.3390
R-squared	0.949983	Durbin-Watson stat.	2.577883	
Adjusted R-squared	0.941873			
CRDW(s)	0.511			

Source: Data Analysis, 2011

Table 2: Response of Rubber to Price Dynamics in Distributive Lagged Model

Variable	Coefficient	Std.Error	t-Statistic	Prob.
Constant	376.3979	102.9944	3.654.548	0.0009
PPR(-1)	0.000322	0.001034	0.311207	0.7575
PPR(-2)	0.000729	0.001784	0.408610	0.6854
PPR (1)	-0.008387	0.080529	-0.00830	0.9756
R-squared	0.542053	F-statistic		6.707408
Adjusted R-squared	0.461239	Prob(F-statistic)		0.000095
Durbin-Watson stat.	0.569065	CDRW(s)		0.511

Source: Data Analysis, 2011