

Hectarage Response to Price and Yield for Sugarcane in Kenya - An Econometric Study

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Abstract

This study identifies the factors responsible for hectarage allocation to sugarcane in Kenya and estimates the short-run and long-run elasticities of sugarcane hectarage with respect to some exogenous variables. Time series data that covered the period of 1962-1992 were used for the study. The analysis was performed using Nerlove's Partial Adjustment Model.

The results of the study indicate that the significant variables influencing sugarcane hectarage are cane and maize producer prices and yield of cane. The short-run elasticity was highest for the producer price of cane with respect to sugarcane hectarages which was estimated to be 0.45. Also, the results of the study showed that only 19 percent of the desired change was as a result of changes in the exogenous variables.

1 Introduction

Agriculture, like in most other developing African countries, is the backbone of Kenya's economy. Its contribution to the Gross Domestic Product (GDP) in the last decade averaged about 30 per cent (KENYA 1989). The sector accounts for more than half of Kenya's export value, the main export commodities being tea, coffee, pyrethrum and horticultural products. Food crops produced include wheat, maize, potatoes and vegetables.

Prior to the mid 1970's, Kenya's domestic food production was keeping pace with the demand. However, by the early 1980's there was a noticeable imbalance between the food supply and demand in the country. As a result, the government initiated the policies of self sufficiency and strategic reserves in food production to ensure that there were enough food for all even in the event of adverse weather conditions. Within this initiative of the government to at least sustain current levels of nutrient intake the sugar industry was not left out. This is because the country is a heavy consumer of sugar with a national average intake of 308,986 tonnes per annum (KENYA, 1989). This however is

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not all. This industry employs an estimated 32,509 people thereby generating a substantial amount of wage employment for the teeming population in the country. The national importance of sugar is reflected in the fact that sugar is among the seven commodities that are considered critical to achieving the country's development goals established for the agricultural sector in the Sixth National Development Plan.

In order to appreciate the contribution of the government towards the development of the sugar industry, it is necessary to place the growth of the industry in a historical perspective. Sugarcane, the raw material for the processed sugar, was introduced into Kenya in the 19th Century. The crop was first produced in commercial quantities in Kisumu and Kwale Districts with the establishment of sugar factors in Ramisi and Miwani in 1920. Cane growing was later extended to Muhoroni and Chemelil, within the now popularly known Nyanza Sugar Belt.

To boost the sugar industry, the government established five new sugar factories at Muhoroni in 1966, Chelil in 1968 Mumias in 1973, Nzoia in 1978 and Sonny in 1980. With this support from the government sugar production increased steadily from a mere 35,300 mt in 1964 to a record level of 441, 300 mt in 1982 (OLALE-AWILLY, 1992).

The production of cane-sugar is, however, mainly in the hands of small-scale farmers who dominate the dualistic farming communities of large and small-scale farmers in the country. Over 83 per cent of the cane delivered to the milling factories are produced by small-scale farmers. In addition, of the 60 per cent of the total farmland put to crop production by small-scale farmers, about 20 per cent is devoted to sugarcane production.

Unfortunately, it is to be noted that over the years, cane production has only been increasing marginally in the country. For example, during the ten year period of 1979 to 1988, the production of sugarcane delivered to factories throughout the country increased only modestly from a figure of 3,002,992 mt in 1979 to 3,835,308 mt in 1988 (KENYA SUGAR AUTHORITY, 1988A).

1.1 Problem Statement and Justification for Study

In recent times, the sugar industry like most other sub-sectors of agriculture has been lagging behind with the result that domestic supply has been well below the aggregate demand. Whereas, sugar production has fluctuated over the years, consumption has steadily increased from 105,100 mt in 1964 to 489,500 mt in 1989, due partly to the rapid population increase. Although the country was able to achieve self-sufficiency by 1979/80, the production in the subsequent years in tonnes per annum has been inadequate for a number of reasons. The shortfalls in production have led to the importation of sugar to close the demand deficit. This has contributed to a drain in scarce foreign exchange and has contributed to the balance of payment problem of the country. Sugar imports have accounted for 15 to 20 per cent of the domestic requirement during the late 1980's and early 1990's (KENYA SUGAR AUTHORITY, 1988B).

Several factors are responsible for the low quantities of cane production and hence the poor performance of the sugar industry as a whole. Natural factors and agronomic factors as well as policy issues constitute basic handicaps and militate against adequate production of this important food item and industrial raw material. The natural factors include rapid population growth rate, which has led to soil over-use and degradation, unfavourable climatic and biased weather conditions and sudden attack of pests and diseases. Agronomic factors include poor soil management as a result of inadequate use of both organic and inorganic fertiliser (MBATA, 1994), inadequate knowledge of modern farming techniques and inefficient farm management practices. The policy issues revolve around the general poor infrastructural base of the agricultural sector, the pricing policy for the major crops produced, including sugarcane, and the mode and time of payment for the cane delivered by the farmers to the factories (SCHLUTER, 1984).

The policy issues in particular have played a major role in the production and hence supply of the sugar in the country. For example, in 1992, the government decontrolled the price of sugar and had to re-control it barely six months later because of the skyrocketing prices that followed. Such an occurrence indicates the importance of sugar in the country and the need to increase the production of raw material for this product. Although the price of sugar has now been decontrolled, the current high consumer price that this product attracts makes it imperative that efforts should be geared towards increased production of the raw material to boost sugar output. This in turn will bring down the price of sugar to levels within the reach of most consumers.

It has been argued that the high level of production of sugar achieved in the 1979/80 was as a result of the increases in the hectares put under sugarcane production relative to other crops. A cursory look also indicates that yields were responsible for the increase in the total amount of industrial sugar produced during the early 1980's; the only time the country attained self-sufficiency in sugar production. This is because cane yield peaked in 1980 but in 1985 declined to as low as 60.1 per cent of the yields recorded in the early 1980's. (ODUOR, 1992).

This study therefore would, as much as possible, establish the factors that affect sugarcane hectareage, how these factors affect the supply function of the crop and whether these factors can be manipulated to achieve the desired hectareage in cane

1.2 Objectives of the study

The main objective of this study is to quantitatively estimate the factors responsible for changes in hectares of sugarcane cultivation in Kenya using time series data. The specific objectives are as follows:

1. To determine how selected exogenous variables affect the hectareage response of sugarcane in Kenya.
2. To estimate the elasticities (short-run and long-run) of the predetermined variables and thus quantify their relative importance on the total hectareage of sugarcane put under cultivation.

3. To make policy recommendations based on the findings.

The rest of this paper is organized as follows: Section 2 deals with the conceptual framework for the study while section 3 discusses the methodology adopted in the study. Section 4 presents the results from the hectareage response analysis and discusses the implications of these results in the light of the study objectives. Finally, section 5 summarises the major findings and puts forward some policy recommendations arising from the study.

2 Conceptual Framework of the Study

In agricultural response analysis, especially with perennial crops, there is usually a time lag between the time policy issues are made and the time it takes the farmers to fully respond to the effects of these policy changes. This situation is derived from the economics of the demand for most commodities especially the non-durable goods. A change in the pricing policy of a non durable good may take a considerable lag before consumers of the particular good respond to that change in terms of increased or reduced demand. This is because of the habit-persistence nature of most human beings. In otherwords, the quantity demanded for most non-durable goods depends among others on the past levels of consumption of the goods (WONNACOTT AND WONNACOT, 1978).

This same argument can be extended to perennial crop production where a certain hectareage of crop would be desired in response to a change in an exogenous variable, say price of output. Mathematically , this relationship can be stated as

$$Y_t^* = \beta_0 + \beta_1 X_{1t} + u_{1t} \quad (1)$$

where: Y_t^* = Desired level of Y in time t and X_{1t} is the predetermined variable during the same period and u_{1t} is the usual random or disturbance term.

However, due to various operational problems, only a fraction of the desired change would be achieved in a particular period. Although, over longer periods, the realized change will tend to approach the desired change. This assumed adjustment pattern which is usually credited to Nerlove (1956) can be expressed as a behavioural rule in line with the theory of demand for a non-durable as follows:

$$(Y_t - Y_{t-1}) = d(Y_t^* - Y_{t-1}) + U_{2t} \quad (2)$$

Where: d = adjustment coefficient which usually lies between 0 and 1, i.e. $0 < d \leq 1$

$Y_t - Y_{t-1}$ is the realised change in the value of Y while

$(Y_t^* - Y_{t-1})$ is the desired changed.

Although, Y_t^* is unobservable and therefore cannot be estimated but it is possible to obtain an estimable form of equation 2 using both equations 1 and 2 by the simple process of substitution and rearrangement of terms. [For details see Olayemi and Olayide (1981) and Koutsoyiannis (1977)].

Thus the estimating form of the Nerlovian model is usually stated as

$$Y_t = d(\beta_0) + (d \beta_1)X_t + (1-d) Y_{t-1} + (du_{1t} + u_{2t}) \quad (3)$$

Equation 3 implies that the present hectareage of crop which the farmers own in any one period t depends partly on the producer price of the output in that period and partly on the existing hectareage at the beginning of the period.

In the Nerlovian partial adjustment model, it is worth noting that the model does not involve autoregressive disturbances in the error terms and this can be estimated using the Ordinary Least Squares (OLS) of regression analysis. In addition, the coefficient $(1 - d)$ of the lagged dependent variable (Y_{t-1}) has an important economic implication and indicates how rapidly adjustment towards equilibrium takes place after changes in the explanatory variables. Above all, it is possible to obtain directly from the model both the short-run and long-run elasticities of the dependent variable with respect to each of the explanatory variables (KOUTSOYIANNIS, *op cit*).

3 Methodology

The methodology adopted for this study involved the use of the time series data to study the supply response of sugarcane (measured by the area put under sugarcane) in Kenya to selected exogenous variables. Data were obtained on area put to sugarcane production, producer price of sugarcane, cane yield and maize prices covering the period of 1962 to 1992. The sources of these data were varied and include the Kenya Sugar Authority, the Central Bureau of Statistics, the Ministry of Agriculture and the Central Bank of Kenya, among others.

The Nerlovian partial adjustment model adopted for this study can be stated implicitly as

$$H_t = f(P_{t-1}, Y_{t-1}, P_{t-1}^m, H_{t-1}, U_t) \quad (4)$$

where

- H_t = Total hectareage of sugarcane in period t
- P_{t-1} = the lagged producer price of sugarcane
- Y_{t-1} = the lagged yield of sugarcane
- P_{t-1}^m = the lagged producer price of maize
- H_{t-1} = the lagged value of the endogenous variable
- U_t = error term

The price of maize was included in the model because of the competitiveness of this crop with sugarcane in the country. Maize is an important staple crop which competes very favourably with sugarcane. Depending on the producer prices for maize and sugarcane, and hence the profit the farmers expect to make from each enterprise, maize can be substituted for sugarcane and vice-versa in a particular cropping season.

On an *a priori* basis, it is expected that the coefficients of the exogenous variables should be positive with the exception of the coefficient for maize price variable. In other words,

$$\frac{\delta H_t}{\delta P_{t-1}} > 0. \quad \frac{\delta H_t}{\delta P_{t-1}^m} < 0.$$

$$\frac{\delta H_t}{\delta Y_{t-1}} > 0. \quad \frac{\delta H_t}{\delta H_{t-1}} > 0.$$

Various functional forms of equation 4 were specified and based on the magnitude of R^2 , the statistical significance of the regression coefficients and the relative freedom of the equations from autoregressive disturbances, the double-log function was chosen (PINDYCK AND RUBINFELD, 1981). Thus the estimating equation is :

$$\text{Ln}H_t = \beta_0 + \beta_1 \text{Ln}P_{t-1} + \beta_2 \text{Ln}Y_{t-1} + \beta_3 \text{Ln}P_{mt-1} + \beta_4 \text{Ln}H_{t-1} + U_t \quad (5)$$

where the variables are as defined earlier.

This is the short-run supply response for sugarcane hectareage from which both the short-run and long-run elasticities of the endogenous variable with respect to the selected exogenous variables and the adjustment coefficient were obtained.

4 Results and Discussion

The ordinary least square technique was used to estimate the hypothesised model in equation 5 and the results are presented in Table 1.

The results of the regression analysis show that the coefficient of all the included variables bore the right *a priori* sign. In addition, all the coefficients were statistically different from zero at the 1% or 5% level. Specifically, the cane price and lagged hectareage variables were statistically significant at 1% while the cane yield and maize price variables were significantly different from zero at 5%. The regression analysis yielded an R^2 value of 0.78 indicating that about 78% of the variation in the hectareage of sugarcane put under cultivation is explained by the exogenous variables included in the model.

As mentioned earlier, it is possible to obtain both the short-run and long-run elasticities of the dependent variable with respect to each of the explanatory variables from the model. In this case, since the fitted regression model is of double logarithmic form, it means that the coefficients of the explanatory variables are in themselves elasticities (KMENTA, 1971). Table 2 presents the short-run and long-run elasticities of the dependent variables with respect to the exogenous variables.

Table 1: Regression Results of Sugarcane Hectarage Response in Kenya, 1963 - 1992 (n = 30, d.f.= 25)

Variable	Parameter	Estimated Coefficient	Standard Error	T-Value
Constant	β_0	3.7157		
Cane Price	β_1	0.4948***	0.1735	2.8518
Cane Yield	β_2	0.0953**	0.0534	1.7846
Maize Price	β_3	-0.1097**	0.0588	1.8649
Lagged Dependent Variable	β_4	0.8115***	0.3248	2.4983
R ²		0.7774		
D.W.		1.8460		

**** = Significant at 1%

** = Significant at 5%

Table 2: Estimates of Short-run and Long-run Sugarcane Hectarage Elasticities

Exogeneous Variable	Short-run Elasticities	Long-run
Cane price	0.45	2.39
Cane Yield	0.01	0.05
Maize price	-0.11	0.54

As expected the long-run elasticities are relatively higher than the short-run elasticities for each of the variables. Worthy of note, is the large elasticity value associated with the price of sugarcane. In particular, in the short-run, a 1 percent increase in the producer price of sugarcane would result in about a 0.5 percent increase in the area of sugarcane cultivated, all other factors being equal. Similarly, a 10 percent increase in the yield of cane would led to 0.1 percent increase in the area of cane put into cultivation while a 10 per cent increase in the price of maize would led to 1 per cent decrease in the area put into sugarcane production.

From the coefficient of the lagged dependent variable, it can be seen that only about 19 per cent of the adjustment required to attain the desired change in cane hectarage as a result of the changes in the included explanatory variables is completed within one year. Other economic implications of the results of the adjustment model can be summarised as follows. Sugarcane hectarage is significantly affected by the producer price of cane. This finding therefore is in the line with the government policy that the annual review of the producer price of cane would act as an incentive to farmers in the production of sugarcane. However, the full effects of this would have been more obvious

and perhaps more rewarding if the producer price for sugarcane for each year has been deflated to take into consideration the inflationary problem in Kenya today.

The statistical significance of the cane yield variable and the positive sign associated with this variable indicate that more land would be devoted to sugarcane production as the yield of the crop increases. This finding suggests that increased yields through the use of better cultivars, modern inputs, and improved agronomic practices are usually translated to relatively higher gross margins for this crop when compared with other crops that are in competition with sugarcane.

The negative sign associated with maize price which is in line with the *a priori* expectations show that maize is indeed in competition with sugarcane in areas where both crops are produced in the country. As the price of maize declines absolutely or increases at a lower rate than the price of sugarcane, farmers would invariably shift to sugarcane production. This finding suggests that farmers are sensitive to changes in the price of major crops grown in the country and would respond by efficiently allocating their scarce land resources according to price movement in the output market.

5 Policy Implications and Conclusion

The results from this study have two main policy implications. First, it is evident from the analysis that government policy of using producer prices to regulate the quantity of sugarcane produced in the country has been successful, at least, to some degree. However, the magnitude of adjustment achieved in a given year (19 per cent) suggests that a considerable time lag exists between the time the producer prices are announced by the government and the time it takes the farmers to respond fully to the new price incentives. In other words, a reasonable level of supply deficit in sugar production, which is usually manifested in sugar scarcity in the country, will still exist for some time before the effects of the new prices are realised, assuming all other things are the same. The fact that there still used to be sugar scarcity before the sugar industry was finally deregulated about two years ago is an indication of the limitation of using the producer price as a policy option for controlling the sugar industry.

Secondly, the study confirms the assertion that maize is highly in competition with sugarcane in the country. The issue that has been frequently raised is: Can sugarcane out-compete maize in Kenya? And if this happens, what would be the implications on the nutritional intake of the population? This author is therefore of the opinion that some kind of balance would be needed to make sure that a cash crop like sugarcane does not make maize production an unprofitable enterprise. Otherwise, the food self-sufficiency objective of the government in the current plant period would become an illusion.

In conclusion, the use of producer price by the government to regulate sugarcane production in Kenya had been effective in increasing the hectareage of production. However, the full effects could not be realized within a reasonable time period. The deregulation of the sugar industry was therefore a move in the right direction, at least in

the short-run. The long-run effects however would need to be studied at the appropriate time to fully establish the full benefits of the deregulated industry and its effects on the food security of the nation.

Anbaufläche von Zuckerrohr in Kenia in Abhängigkeit von Preis und Ertrag - eine ökonometrische Studie

Zusammenfassung

Diese Arbeit befaßt sich mit den Faktoren, die den Anbau von Zuckerrohr beeinflussen und schätzt die kurzfristigen und langfristigen Elastizitäten ein unter Berücksichtigung von einigen äußeren Variablen. Die Untersuchung umfaßt die Zeitspanne von 1962 bis 1992 und benutzt das Nerlove Partial Adjustment Modell.

Die Ergebnisse dieser Studie zeigen, daß die signifikanten Variablen, die die Anbaufläche beeinflussen, der Zuckerrohr- und der Maispreis sowie der Zuckerrohreertrag sind. Die kurzfristige Elastizität war am höchstens bei dem Erzeugerpreis von Zuckerrohr und wurde auf 0.45 geschätzt. Die Ergebnisse der Untersuchung zeigen, daß nur 19 % von den gewünschten Veränderungen auf Änderungen der äußeren Variablen zurückzuführen sind.

6 References

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