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Staple food policy and supply response in Nigeria: A case of cassava

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Abstract

Increased government concern in making agriculture a major foreign exchange earner and contributor to the nation's gross domestic product as part of its economic diversification agenda leads directly to a need for information about farmers' response to changes in price and non-price factors. This is particularly important in the case of Nigerian cassava production; having assumed a centre stage as a potential export crop, and in spite of constituting a significant proportion of staple diets of Nigerians. This paper analyses the supply response of cassava farmers in Nigeria using a dynamic regression model. The results show that tinkering with price and market incentives may have adverse effects on farmers' response, and in turn government's objective of making cassava a foreign exchange earner for the country. Again, the paper reveals that contractionary fiscal policies would hurt crops such as cassava, which are responsive to non-price fiscal incentives.

Key words: Cassava, food policy, supply, price, elasticity, partial adjustment.

Introduction

Nigeria, like most other countries in developing Africa, has been reputed to be food deficient and import dependent. Hence, the substitution of food imports for food crop production in the country is an issue of concern. In that respect, a logical starting point is the analysis of the response of farmers to changes in the variables, which influence the supply of food crops.

Government efforts geared at increasing food production in Nigeria have a rich background. The government has, over the years, formulated policies and embarked on various programmes with a view to addressing the challenge of low food and aggregate agricultural production. These policies and programmes have included agricultural pricing policies and other non-price incentives that were aimed at providing market signals and removing market distortions to which farmers may respond. The end result being that farmers like other economic agents are rational in their behaviour and would respond to market incentives to increase their production, especially in those crops in which the country has comparative resource advantage.

Nigeria has comparative resource advantage in the production of cassava (Agricultural Policy for Nigeria, 1988), and is the world's leading producer of cassava, with 33 million metric tons of fresh tubers per annum [7]. Cassava is a very important crop in Nigeria based on its extensive use, especially as a staple food to most Nigerians [6] and because of the high export demand of some of its products, namely starch, chips, pellets, flour, etc. It is well adapted to various climatic and soil conditions and yields mostly above 22.0 metric tons per hectare even on poor soils, which gives it superior advantage over other tuber crops like yam, cocoyams and potato [1, 12]. The economic diversification agenda of the Federal Government of Nigeria in the past three years has placed premium on strengthening the agricultural sector in general and boosting cassava and rice production in particular. In that regard, government notes that cassava is the single most important food commodity in the country with a high potential for earning huge amounts in terms of foreign exchange and ensuring food security in the country, while rice is one of the most important staple food crop in the county's food import basket.

Consequently, government, in 2002, intervened in the production of cassava, and accordingly announced a ban on the importation of cassava and cassava products. To that effect, government inaugurated a committee with a responsibility of ensuring that the country becomes self-sufficient in the production of cassava. In 2004, government reiterated its commitment in the Cassava Project, announced another ban on the importation of cassava and cassava products, and hence inaugurated a Cassava Export Committee, charged with the responsibility of accelerating the production of cassava for export amid other functions. Government's intention in taking this course of action was to increase the supply response of cassava farmers in Nigeria by making them respond to product prices and market incentives.

Supply response measures the degree to which the level of production and/or marketed surplus changes in response to stimuli provided by changes in some important variables, mainly prices. In other words, it attempts to explain the behavioural changes of producers with respect to the production, consumption and exchange decision of a certain product or set of products due to changes in economic incentives [9, 16].

The theoretical literature of supply response assumes that economic agents, notably, farmers respond to the relevant price and non-price variables and falls into three groups [10]. The notion in the first group is neo-classical and their theory is entrenched in three central postulations, namely that there is perfect competition in the market; prices are the most efficient system of information and incentives; adjustment is fairly smooth through price signals [14]. The neo-classical points of view, however, fail to recognise that arguments surrounding the question about how much of a given product or set of products should be produced in response to changes in economic incentives are predicated upon certain predetermined perceptions regarding the objective functions of the producers and that of the behaviour of the markets.

The view of the second group, which blames irrational response of the agents to price signals on structural rigidities of less-developed economies, is due to unavailability or poor non-price incentives. The World Bank, cited in Nyong [18] indicates that inadequate infrastructure; incomplete markets, rudimental industrial sector, as well as severe institutional weaknesses in the public and private sectors are key non-price factors that impede smooth supply response of agricultural commodities to economic reforms in sub-Saharan Africa. Thus, these have caused a bias in policy against agriculture in many developing countries [4, 15].

The third group of literature admits that the simultaneous nature of the response pattern of economic agents is due to price and non-price variables. This conforms with the view of Nyong [18] who avers that a common criticism of conventional supply response is that the exclusion of non-price incentives weakens the strength of response of economic agents. This group finds the basis of its proposition on the basic Nerlove model of adaptive price expectations and partial adjustment, which makes use of both price and non-price factors as important determinants of farmers' supply response [5, 22].

Supply response studies can be addressed empirically using total production (or marketed surplus), hectarage, or yield as an appropriate index of the dependent variable with which farmers' responsiveness could be modelled. However, the difficulty in measuring farmers' intentions and the conceivable discrepancy between intentions and actual performances has led analysts to dwell more on cultivated hectarage as dependent variable. This is because the type and amount of crop the farmer intends to produce may better be estimated by the area allocated (and worked) to such a crop rather than actual harvest. Yield, on its part, does not approximate farmers' intentions because it is influenced by factors outside his control, and in the context of developing countries, where technological stagnation characterises agricultural production, yield is generally insensitive to price incentives. Thus, elasticities calculated from models in which cultivated area is the dependent variable probably better approximate the derived elasticities of planned output for agriculture, *ceteris paribus* [9, 13].

The empirical literature on supply response of farmers is diverse [3, 17, 19, 21, 23, 24]. These studies test the hypothesis that the output and/or area of crops respond significantly to movements in the relevant price and non-price variables. Their results show that the production of agricultural crops is sensitive to price changes and other non-price variables, albeit at varying degrees.

In view of the changes in policy environment, and the apparent dearth of information on the response of cassava farmers to price and non-price incentives in Nigeria, this study attempts to fill the information gap, and to add value to the existing body of evidence on the supply response of food crops in the country. Consequently, the questions addressed are: what is the nature of the response of cassava farmers to changing price and non-price factors in Nigeria from 1970 to 2002? How does the real exchange rate rub on cassava hectarage expansion, given that food imports may be competing more with cassava that makes up the consumption bundle of the Nigerian poor?

Analytical Framework

The Model: Following the formulations advanced by Nerlove in 1956 and 1958 [16], the model for an annual crop consists of three equations (see, equations 1, 3, 5).

The actual adjustment of hectarage in one time period is specified as some proportion (β) of intended full adjustment to the desired or equilibrium hectarage, $Y^*_{t.}$

$$Y_t - Y_{t-1} = \beta\,(Y^*_t - Y_{t-1}); \qquad 0 < \beta \le 1 \qquad (1)$$

$$\text{Thus, } Y_t = \beta Y^*_t + (1-\beta)Y_{t-1} \ldots\ldots\ldots \qquad (2)$$

Since farmers base their production plans on expected prices, equation (3) was pursued, and following a similar logic, the change in price expectation is specified as some proportion (δ) of the error made in formulating expectations in the last year.

$$P^*_t - P^*_{t-1} = \delta\,(P_t - P^*_{t-1}); \qquad 0 < \delta \le 1 \ldots \qquad (3)$$

$$\text{Therefore, } P^*_t = \delta P_t\,(1-\delta)P^*_{t-1} \ldots\ldots\ldots\ldots\ldots \qquad (4)$$

However, desired or equilibrium output (Y^*_t) can be specified as a function of expected price (P^*_t) and other exogenous variables which influence supply, hence:

$$Y^*_t = a_0 + a_1 P^*_t + a_2 Z_t + U_t \ldots\ldots\ldots\ldots \qquad (5)$$

Since (P^*_t) is unobservable, we assume that farmers make their planting decisions based on their knowledge about prices that prevailed immediately in the preceding period (that is, $P^*_t = P_{t-1}$). Hence, (P^*_t) is taken to be the lagged price, and when the other variables which affect supply are included in equation (5), we have

$$Y^*_t = a_0 + a_1 P_{t-1} + a_2 PA_{t-1} + a_3 ER + a_4 CE_{t-1} + a_5 F_{t-1} + a_6 W_t + a_7 D + a_8 T + U_t \ldots\ldots\ldots \qquad (6)$$

Substituting (6) into (2), the following estimation equation was obtained:

$$Y_t = a_0\beta + a_1\beta P_{t-1} + a_2\beta PA_{t-1} + a_3\beta ER + a_4\beta CE_{t-1} + a_5\beta F_{t-1} + a_6\beta W_t + a_7\beta D + a_8\beta T + (1-\beta)Y_{t-1} + e_t \ldots\ldots\ldots\ldots \qquad (7)$$

So that the reduced form of equation (7) becomes:

$$Y_t = b_0 + b_1 P_{t-1} + b_2 PA_{t-1} + b_3 ER + b_4 CE_{t-1} + b_5 F_{t-1} + b_6 W_t + b_7 D + b_8 T + b_9 Y_{t-1} + e_t \ldots\ldots\ldots\ldots\ldots\ldots \qquad (8)$$

Note, however, that:
$b_0 = a_0\beta$; $b_1 = a_1\beta$; $b_2 = a_2\beta$; $b_3 = a_3\beta$; $b_4 = a_4\beta$; $b_5 = a_5\beta$; $b_6 = a_6\beta$; $b_7 = a_7\beta$; $b_8 = a_8\beta$; $b_9 = (1-\beta)$.

Y_t...... Actual hectarage of cassava in year, t

Y^*_t.... Expected hectarage of cassava in year, t

Y^*_{t-1}...Desired or long-run equilibrium hectarage of cassava in year, t

P_t....... Actual price of cassava in year, t

P_{t-1}..... Lagged price of cassava in year, t

β .... Coefficient of hectarage adjustment

δ .... Coefficient of price expectation

PA_{t-1}... Lagged price of rice in year, t

RER_t Real exchange rate (trade-weighted) in year, t
CE_{t-1}...Government capital expenditure on agriculture lagged one year
F_{t-1} ..... Quantity of fertilizer distributed to farmers lagged one year
W_t ..... Weather variable (rainfall was used as proxy)
D...... SAP dummy – to capture government policy shifts
T .... Trend variable – to capture technological change over time
e_t ...... Error term (satisfying the normal classical regression assumptions)

For the inclusion of the real exchange rate and other non-price variables in equation (8), see specifications by Garba *et al.*[10] and Gabriel[9].

The short- and long-run elasticities were derived from the autoregressive distributed lag equation (8). Specifically, the short- and long-run elasticities for the linear form of (8) were taken as b_1 x (P/Y) and (b_1/β) x (P/Y) respectively, where P and Y are mean values of price and hectarage in that order. In the log form of the equation, b_1 and (b_1/β) directly measure short- and long-run price elasticities respectively [3, 9].

The Data: The study used macro level data from 1970 to 2002, which were sourced from the Central Bank of Nigeria's (CBN) online database (www.cenbank.org), the Federal Office of Statistics' (FOS) Annual Abstracts of Statistics and Federal Ministry of Agriculture's Department of Fertilizer Procurement and Distribution (FPDD).

The cross-price effect in the model makes use of the price of rice. In Nigeria, about 46% of the total area devoted to rice cultivation is for rain-fed upland rice and irrigated production systems, each accounting for 30% and 16% respectively [2]. Again, rice is one of the most important import staple food commodity in the country whereas cassava is the single most important exportable staple food commodity with a potential for ensuring food security in the country. Thus, changes in rice prices would be expected to evoke significant changes in the prices of cassava, and hence cultivated cassava hectarage. Consequently, *a priori*, the sign of the coefficient of the rice price variable would be negative if cassava and rice are substitutes in production/or consumption, and so the presumption is that farmers would respond inversely to cross-price changes.

The movement in the real exchange rate is expected to capture the substitution effects in both production and consumption between food imports and domestic production of food and to act as proxy for excluded macroeconomic variables. The impact of the changes in the real exchange rate would be difficult to determine *a priori* since the sign that its coefficient would assume would be mixed for exportable food crops and food imports.

The quantity of fertilizer distributed to farmers is taken as a proxy to the availability of purchased inputs. It is expected that as the availability of fertilizer per unit cost improves, farmers would expand area under production.

The influence of weather was captured by the use of average annual rainfall, because in the African framework, rainfall is a crucial determinant of agricultural production due to the fact that most of the crop production systems are rain-fed. The sign of the coefficient of this variable is indeterminate *a priori*. Crops would respond variously to changes in rainfall pattern depending on their ecological adaptations.

Capital expenditure on agriculture (fiscal policy variable) is a non-price incentive to agricultural supply and enables subsidies to agriculture and the construction of economic infrastructure, which supports agriculture, for example dams, road, silos, etc. The presumption is that its coefficient should take on a positive sign.

Results and Discussion

The results of the preferred specification are shown in Table 1. The estimation equation specified (8) in the previous section was pursued using the backward elimination method of the ordinary least squares multiple regression, which sequentially deleted insignificant regressors to arrive at the preferred and/or parsimonious specification (parsimony seeks to maximise the goodness of fit of the model with a minimum number of explanatory variables).

Estimates show that the coefficients of all the regressors have the hypothesized signs and are (except weather) statistically significant at 10% level of probability and less. The result of the only diagnostic test carried out indicated the absence of serial correlation among successive error terms.

The empirical results show that short-run changes in own-price, cross-price, lagged hectarage and capital expenditure on agriculture all play a significant role in shaping cassava supply behaviour between 1970 and 2002 in Nigeria. Moreover, the long-run sensitivity of hectarage to own-price is elastic, given an adjustment coefficient of 0.6718 (implying that the rate of farmers' adjustment to long-run equilibrium is about 67%).

These estimates carry some policy implications. The own-price elasticity cassava hectarage in the short- and long-run is 0.7108 and 1.058 respectively, meaning that own-price is inelastic in the short-run and almost unitary elastic in the long-run. Thus, a 10% rise in the price of cassava, *ceteris paribus*, would lead to a 7.10% and 10.58% expansion of cultivated cassava hectarage in the short- and long-run in that order. This implies that hectarage supply of cassava is highly sensitive to price signals in the long-run. Therefore, improved cassava pricing would evoke a larger than proportionate supply response by cassava farmers.

The cross-price elasticity is -0.8904 indicating that cassava and rice are substitutes in production. Thus, a 10% decrease in the price of rice would lead to an 8.9% expansion in cassava hectarage in the short term.

Although the elasticity of the fiscal policy variable (capital expenditure on agriculture), 0.4029, is inelastic in the short-run, its statistical significance has some implications. For example, we had stated earlier that the aggregate nature of this variable, its changes are likely to dampen the effect of changes in variables like input availability/cost in explaining smallholder supply

Table 1. Modelling Y_t by OLS - preferred specification.

Regressor	Coefficient	t-statistic	P-value
constant	-536.231	-1.159	0.2580
P_{t-1}	0.7108	2.5434	0.0181
PA_{t-1}	-0.8904	-2.845	0.0091
Y_{t-1}	0.3282	1.9162	0.0678
CE_{t-1}	0.4029	1.9537	0.0629
W_t	0.8226	1.3387	0.1937
R squared	0.9550		
Adjusted R squared	0.9458		
F-statistic	98.789		0.0000
DW statistic	1.929		
Durbin's h statistic	undefined		

behaviour since the availability of inputs such as fertilizers, are facilitated by capital expenditure allocations to agriculture. Thus, it should not be viewed that smallholder farmers do not respond to non-price incentives such as fertilizer. The fact that the quantity of fertilizer applied to each crop is not known may have cooperated with the fiscal policy variable to remove the input availability variable from the preferred specification.

That the weather variable was not significant at 10% or less is understandable. The present study modelled hectarage response, which is largely a function of expectations, not yield response, which is primarily a function of uncontrollable variables, such as weather, specifically rainfall. Thus, weather remains a crucial determinant of supply response, especially in sub-Saharan Africa.

On a general note, all the coefficients are fairly inelastic in the short-run, while own-price elasticity is elastic in the long-run. Their values are high compared with previous studies for Nigeria. However, caution must be exercised in making such comparisons since the number of years or length of observations covered and/or degrees of freedom are usually not the same.

Conclusions – A Reminder for Policy Makers

This study has examined the supply response of smallholder cassava farmers in Nigeria, spanning 1970 to 2002. The model specification is founded on the basic Nerlovian model of price expectations and partial area adjustment, while the estimation procedure uses the backward elimination method of the OLS multiple regression. Quantitative estimates show that the short-run changes in own-price, cross-price, capital expenditure on agriculture and lagged hectarages, significantly explain the response of cassava farmers during the period under review.

Specifically, the elastic nature of cassava price suggests that cassava hectarage is highly sensitive to changes in cassava prices in the long-run. Thus, tinkering with cassava prices in the long-run may not achieve government's objective of making cassava a major foreign exchange earner for country. Provision of market incentives, such as export promotion grants and/or zero export tariffs, is likely to increase hectarage expansion in the long-run.

That cassava and rice are found to be substitutes in production, with an almost elastic cross-price response, indicates an inter-crop competition for land used in their production. Therefore, since rice is a major food import commodity and cassava a potential export commodity, a trade-off in rice production, should compare own-price sensitivity of both crops in both the short- and long-run.

Capital expenditure on agriculture was significant in explaining hectarage response of cassava farmers and captures non-price incentives to some extent since it enables provision of subsidies and economic infrastructures to agriculture. Hence, contractionary fiscal policies would hurt cassava and other crops that are sensitive to non-price fiscal incentives.

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