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Cassava output supply response in Nigeria: A Vector Error Correction Model (VECM) approach

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ABSTRACT

The response of agricultural commodities to changes in price is an important factor in the success of any reform programme in agricultural sector of Nigeria. The producers of traditional agricultural commodities such as cassava face the world market directly. Consequently, the producer price of cassava has become unstable and this creates a dis-incentive for production thus making output and exports suffer. This study investigated cassava supply response to changes in price. Data collected from FAOSTAT from 1966 to 2010 were analysed using Vector Error Correction Model (VECM) approach. The results of the VECM for the estimation of short run adjustment of the variables toward their long run relationship showed a linear deterministic trend in the data and that Area cultivated and own prices jointly explain 74% and 63% of the variation in the Nigeria cassava output in the short run and long-run respectively. Cassava prices (P↓0.001) and land cultivated (P↓0.1) had positive influence on cassava output in the short-run. The short-run price elasticity was 0.38 indicating that price policies are effective in the short-run promotion of cassava production in Nigeria. However, in the long-run elasticity cassava does not responsive to price incentives significantly. This suggests that price policies are not effective in the long-run promotion of cassava production in the country owing to instability in governance and government policies.

Keywords: Cassava output price, Co-integration, long-run elasticity

PAPER

1. Introduction

In recent times, 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 price of these commodities has become unstable and this creates a 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 cassava and other cash crops farmers in Nigeria are able to sell their output, to a large extent, depend on how they respond to both local and global demand. For many low income countries, the impact of structural reforms on economic growth and poverty alleviation crucially depends on the response of aggregate agricultural supply to changing incentives. The ability of the agricultural policy community to respond to this challenge is impaired by relative scarcity of current market prices and missing information of basic information about the supply of agricultural output, which makes the forecasting of supply response difficult. Agricultural supply response is the change in agricultural output owing to a change in agricultural output price (Mythili, 2008) and this may be policy-induced. In Nigeria, the producers of traditional agricultural commodities like cassava face the world market directly. They reap profits when prices are good but absorb shocks and suffer losses when prices fall (Obayelu and Salau, 2010). Consequently, the producer's price of these commodities has become unstable and this create dis-incentive for production and 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.

In agricultural development economics, the most important issue is supply response since the responsiveness of farmers to economic incentives largely determines agriculture's contribution to the economy. The response of agricultural supply to price movements has been the subject of long and vigorous discussion, going back to Nerlove's classic treatment of the long-run supply elasticity for corn, cotton and wheat in the United States (Nerlove 1958). Estimates of supply elasticity (short-run and long-run) based on the Nerlove model vary widely by crop and region. Furthermore, the response elasticities are also important for policy decision regarding agricultural growth. Therefore considering of these limitations, the current study utilizes the new developments of econometric techniques in analysis that can estimate distinct short-run and long run elasticities to overcome the problem usually encountered in the traditional Nerlovian model. However, the Error Correction Model (ECM) with co-integration analysis is preferred to the Nerlovian model because it not only overcomes the restrictive dynamic specification of the Nerlove method, but also captures the forward-looking behaviour of producers optimising their production in dynamic situations. ECM is used to analyse non-stationary time series that are known to be co-integrated.

The measurement of agricultural supply response not only prove useful to policy makers, it also facilitates informed decision making by farmers and other players in the production marketing chain and ultimately better prices for the consumers. The responsiveness of farmers to price and non-price incentive or disincentives will provide a clear picture of contribution of agricultural sector to the economy and this will depend often on the responsiveness of domestic agricultural production to price in particular. In Nigeria, a substantial literature on agricultural output supply response exists but little of this is directly relevant to cassava. However, crop-specific data on supply elasticities are needed to ensure relevant policy analysis. Ojiako et al., 2008 studied cassava output supply response but limited their studies to non-price factors. Any attempt to reform the structure of incentives provided by cassava farmers will require a detailed knowledge of cassava supply parameters. Hence, the use of VECM approach to investigate the response of cassava output supply to the real prices with a lapse of time. This study therefore analyzes cassava farmers' responsiveness on the price from the period of 1966 (when the first military coup took place) to 2010.

2. MATERIALS AND METHODS

The study sourced data from Food and Agricultural Organization of the United Nation (FAO), Central Bank of Nigeria (CBN) and National Bureau of Statistics (NBS). The variables chosen include cassava output, area, real prices of cassava, land area cultivated. Raw cassava price data from 1966 to 2010 were deflated using 2012 consumer price index. Each of the series was then tested for the presence of a unit root by estimating an Augmented Dickey Fuller (ADF) equation. The first lagged difference of all non-stationary series and again estimated ADF equation both with and without the deterministic trend.

The cointegration and the Vector Error Correction Model (VECM) were estimated using the Johansen (1988) test which estimates Vector Error Correction Models (VECM) of the form:

$$\Delta Y_t = c + \sum_j \alpha_j \Delta Y_{t-1} + \delta D_t + \gamma T + \lambda \varepsilon_{t-1} + \vartheta_t \quad (1)$$

$$\varepsilon_{t-1} = lnY_{t-1} - \sum_j \beta_j Y_{jt-1} \text{ (error/equilibrium correction term)} \quad (2)$$

Where where Δ is the deference operator such that $\Delta Y_t = Y_t - Y_{t-1}$, Ys are the (assumed) co-integrated time series variables (including pervious supply levels $Y_{t-n}$and explanatory variablesX_{t-n}). D_t is a vector of stationary exogenous variables; δ is vector of parameters of exogenous variables; λ is the coefficient of error correction term ε_{t-1}. αj and βj are respectively vectors of short-run and long-run supply elasticities with respect to factor j.

The Johansen method provides two likelihood ratio tests, namely the Trace and the Maximum Eigen Value statistic tests, which are used to determine the number of co-integrating equations given by the co-integration rank r. A co-integration equation is the long-run equation of co-integrated series. The Trace statistic tests the null hypothesis of r co-integrating relations against the alternative of k co-integrating relations, where k is the number of endogenous variables for r = 0, 1,..., k – 1. The Maximum Eigen Value statistic tests the null hypothesis of r co-integrating vectors against the alternative of r + 1 cointegrating vectors.

When the co-integration rank r is equal to 1, the normalisation restriction for the parameters produces a unique estimate of what the economic theory suggests (Golinelli, 2003). However, when there is more than one co-integration equation the Johansen approach to co-integration analysis is preferred to the Engle-Granger approach (Thiele, 2003).

The VECM was specified as:

$$\Delta \ln Y_t = c + \alpha_0 \Delta \ln P_{t-1} + \alpha_1 \Delta \ln k_{t-1} + \alpha_2 \Delta \ln C_{t-1} + \gamma T + \lambda \varepsilon_{t-1} + \vartheta_t \quad (3)$$

Where $\varepsilon_{t-1} = \ln Y_{t-1} - \beta_1 \ln P_{t-1} - \beta_2 \ln K_{t-1} - \beta_3 \ln C_{t-1}$

For this study:

$$\Delta \ln Y_{t-1} = C + \alpha_0 \ln P_{t-1} + \alpha_1 \ln A_{t-1} + \varepsilon_{t-1} \quad (4)$$

Where:

Y_{t-1} = lagged Output

P_{t-1} = lagged price of cassava

A_{t-1} = lagged Area of land cultivated

C = Constant

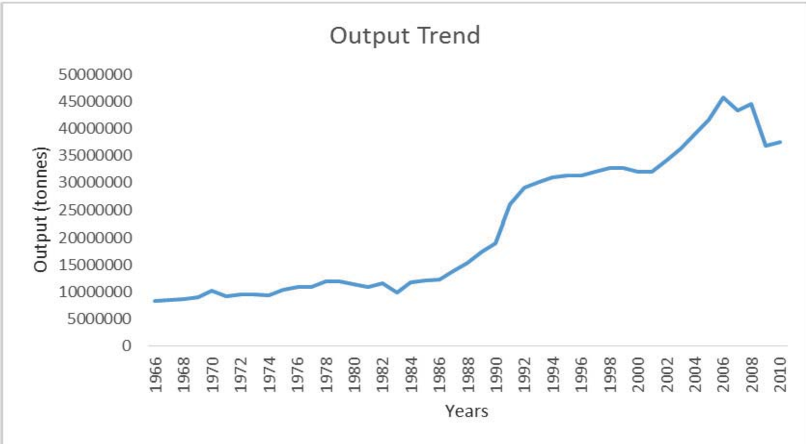
ε_{t-1} = lagged Error term

3. RESULTS AND DISCUSSION

The trend analysis in Figure 1 shows that between the periods of 1966-1985, what has popularly come to be known as the pre-Structural Adjustment Program (SAP) era, cassava production was at best described as stagnant as there was no real growth in the sector. This was the outcome of the oil boom of the 1970s, which later led to the "Dutch syndrome". In the late 1980s, the military regime international financial institutions supported the introduction of Structural Adjustment Programme (SAP) in Nigeria to correct market and price distortions. The SAP was a policy measure towards a more market-friendly trading system and the dissolution of commodity marketing boards as well as elimination of the heavy dependence on crude oil export and import of consumer and producer good (Ihimodu, 1993). During the SAP era, cassava output grew steadily from about 10 million tonnes (MT) in 1985 to 30 MT 1994. Thereafter, it took a downward trend but for the timely intervention of the Presidential Cassava Initiative under the Obasanjo regime from 1999 to 2007 and peaked in 2006 to about 49 MT.

Efforts of the Obasanjo regime to diversify the Nigerian economy from an oil-based economy led to growth in the agricultural sector including the exponential expansion of cassava production from 2003 to 2007. However, the glut created in the market, which coincided with a change in government and government policy focus, led to sharp decline in cassava output to about 35 MT in 2008. The seven-point agenda of the Yaradua government included agricultural sector development but were later actualised by Goodluck Jonathan regime. Local content policies, such as the popular cassava flour inclusion in the milling industry and bilateral agreements with multinationals in the textile and the pharmaceutical industries, resulted in the upward trend of cassava output in 2010.

Figure 1 - Trend Analysis of Cassava Production Output



Trend Analysis of Raw Cassava Prices

The agricultural production like any other around the world responds not only to non-price factors such as policies and weather but also to price incentives. Figure 2 shows that cassava prices were low and stable relatively during the pre-SAP period (1966-1985) but a sharp change is noticed in the price movement which also corresponds with exponential increase in production output immediately after the introduction of SAP. The sharp decline in the price of cassava around 2008 can be attributed to the glut in the market at the period. From then onwards, there has been an undulating increase in the trend of cassava price.

Figure 2 - Trend Analysis of Cassava Prices.

Stationarity Tests

The unit root test using the Augmented Dickey Fuller (ADF) is presented in Table 1 shows that that all the variables are non-stationary in their levels but are stationary at first differences. The test used the MacKinnon (1991) critical values for the rejection of the null hypothesis of no unit root. This indicates that the variables 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 spurious results and not such results cannot be used for prediction in the long-run (Mesike et al., 2010). Therefore, the test of co-integration was applied to the series data which were integrated in the same order I(1) and did not have a unit root.

Table 1 - Augmented Dickey Fuller (ADF) Stationarity Test Results

ADF Test Critical Values					
Variables	Statistics	1%	5%	10%	Inference
D(Y)	0.5469	-3.6056	-2.9369	-2.6069	I(0)
	-3.6416	-3.6105	-2.9390	-2.6080	I(1)
D(A)	-1.6330	-4.9809	-3.5155	-3.1883	I(0)
	-5.8244	-4.1865	-3.5181	-3.1897	I(1)
D(P)	-1.0804	-4.1985	-3.5236	-3.1929	I(0)
	-4.7951	-4.2050	-3.5266	-3.1946	I(1)

Key: ADF = Augmented Dickey Fuller; I(0) = non-stationary at level; I(1) = stationary at first difference; D(Y) = Output of Cassava; D(A) = Area; D(P) = Price of Cassava;

Cointegration Test

The Johansen's co-integration test shows the presence of three co-integrating equations at 5% level of significance implying that there is a common trends in the process (Table 2). The co-integration tests are to test whether there is a statistical significant linear relationship between the different time-series data. Test statistics from the maximum Eigen value are consistent in suggesting that there are two integrating vectors among the variables. This implies that the explanatory variables are co-integrated and have short run and long run relationships with the dependent variable.

The statistical evidence of co-integration supports the theory of long-run equilibrium between supply and output. It also supports three co-integration relation between the series and hence the decision regarding co-integration equation. The results, based on both the trace test and maximum Eigen value test showed the existence of three co integrating vectors and the rejection of the null hypothesis of r = 0. Thus, there is a long-run co-integrating relationship among the variables. This is consistent with the findings of Hallam and Zanoli (1992) as cited in Obayelu and Salau (2010) that where only one co-integrating equation exists, its parameters can be interpreted as estimate of long-run co integrating relationship between the variables concerned.

Table 2 - Summary of Co integration Test. (Result of Johansen Trace Test).

Hypothesised No. of CE	Null Hypothesis	Alt. Hypothesis	Eigen Value	Trace Stat.	5% Critical value
None	r = 0	r=1	0.6611	92.6800	69.8188*
Atmost 1	r<1	r=2	0.5199	55.8934	47.8561*
Atmost 2	r<2	r=3	0.4202	30.9472	29.7971**
Atmost 3	r<3	r=4	0.2974	12.4147	15.4949
Atmost 4	r<4	r=5	0.0122	0.4157	3.8415

Hp: rank = p(no deterministic trend in data) Hr: rank r<p Co integration relations.
** (*) denotes rejection of hypothesis at 5% (1%) significant levels. Test indicates 3 cointegrating equations(CE) at 5%.

Vector Error Correction Estimates

Lagged variables were used in the estimation of cassava output, as the production decisions of the famers are mostly made in the previous period and they are not altered on real time basis due to change in any of the variables. The result shows that the independent variables jointly explain 74.01% of the variations in the cassava output in the short-run. The elasticity of current production with respect to previous production is 37.7%. Most parameter estimates are within reasonable ranges and suggests a relatively strong short-run supply response to prices, meaning an increase in aggregate cassava output in the short-run will lead to a decrease in the price of cassava (Obayelu and Salau, 2010). The estimated speed of adjustment was significant at one percent and this reveal that cassava supply adjusts to correct for short-run disequilibrium between itself and its price. The error correction coefficient was very high (98%) and has a negative sign as expected, suggesting that feedback mechanism is high in converging cassava supply towards long run equilibrium despite the shocks in cassava supply and prices.

Production decisions are mostly made in the previous year and they are not subject to alterations on real time basis due to change in any of the variables (Ozkan, 2011). Thus, considering the annual structure of the cassava production, the amount of production in the previous year is correlated with the current production. The negative sign on the lagged cassava output suggest that when there is a market glut in the previous period, cassava could be replaced with its substitutes such as yam and sweet potatoes. In other words, an increase in cassava supply resulting in a decline its price will make the famers shift cassava production to its close substitutes like yam, thereby reducing its output supply. This makes them eligible for this substitution in the long-run. The opportunity to utilize substitutes is a key proviso that is attributable to the negative constant of the estimation. The cassava price elasticity and the elasticity of farm size in the short-run were 0.38 and 0.27 respectively suggesting that a percentage increase in both the lagged price of cassava and farm size price lead to a less than proportionate percentage increase in aggregate cassava supply in the short-run. This indicates that cassava supply is price inelastic in the short-run. Also, cassava farmers in Nigeria do not make adequate short-run production expansion adjustments in response to changes in expected prices. This may be due to relative price stability overtime and non-price determinants of supply response.

Table 3 - Short-run Relationship Estimates.

Variables	Co-efficient	St. Error	t. value
C	-270459.2	238197.5	-1.135441
D(Y-1)	-0.377316***	0.118843	-3.174918
D(A-1)	0.2749004*	0.141884	1.937497
D(P-1)	0.382407***	0.104133	3.672281
E-1	-0.980299***	0.148231	6.613324
R. Squared.	0.740103		
Adj. R. Square	0.704255		
S.E. Equation	1.388426		
Sum of Sq. res.	5.59E+13		
Log likelihood	-526.4250		
F. Statistics	20.64568		
Mean dep. Var.	-258167.6		
S.D Var.	2553079		
Akaike Info. C.	31.26029		
Shwarz C.	31.48476		
Dubin Wat. St.	1.014693		

(***) * Significant at (1%) and 10% respectively

In the long-run all the explanatory variables explain 63 percent of the variations in the cassava output. The coefficient of the error term is significant and greater than unity in the long-run and is consistent with the findings of Obayelu and Salau (2010), implying a high speed of adjustment towards equilibrium. In other words, the speed at which cassava output adjusts to the explanatory variables in the long-run is 100.5%, which is a marginal increase from 98% in the short-run. However, lagged cassava price is not significant in the long-run suggesting that price policies are not effective in the long-run promotion of cassava production in the country owing to instability in governance and government policies. This is consistent with the findings of Ozkan et al., 2013 that current production did not respond significantly to the lagged own price of wheat in the long-run in Turkey. However, it contrasts the findings of Ogundari and Nanseki (2013) that maize supply responds significantly and positively in the long run to own price in Nigeria.

Table 4 - Long-run relationship estimates.

Variables	Co-efficient	Standard Error	t-value
C	767457.7***	249459.7	3.076480
Y-1	-0.03460	0.172640	0.200535
A-1	0.733647	1.721046	0.426280
P-1	0.2182142	2.083508	0.104734
E-1	1.005688***	0.156314	6.433782
R. Squared.	0.637226		
Adj. R. Square	0.587188		
S.E. Equation	1452898		
Sum of Sq. res.	6.12E+13		
Log likelihood	-527.9682		
F. Statistics	12.73488		
Mean dep. Var.	773655.9		
S.D Var.	2261304		
Akaike Info. C.	31.55107		
Shwarz C.	31.42762		
Dubin Wat. St.	1.060433		

(***) significant at 1%.

4. CONCLUSION

The result of the trend analysis showed that cassava development and production output have risen over the years in Nigeria in the recent past and that price plays a significant role in production decisions as evidenced by the fall in production around the period of 2008. Cassava has the potential to feed the growing population and still have reserves for export purposes if the current policies, initiatives are maintained and improved upon. It is recommended that policy makers (e.g. government) should come up with a way of stabilising production and price by taking care of the glut in the system. The farmers can also protect themselves from the effects of price fluctuations are to diversify by providing other value addition on cassava.

The area elasticity coefficient from the short run VECM analysis shows that increase in the area cultivated will lead to an increase in cassava output, efforts should therefore be put in place by government and extension agents to increase the area cultivated and improve the yield potentials in terms of productivity of the fields thereby maximising output.

It has been observed from the short run VECM study, that cassava has high price elasticity. Policies should be put in place that stabilises the price of cassava in the market.

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