An Ordered Probit Model Analysis of Transaction Costs and Market Participation by Small-Holder Cassava Farmers in South-Eastern Nigeria.

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AN ORDERED PROBIT MODEL ANALYSIS OF TRANSACTION COSTS AND MARKET PARTICIPATION BY SMALL-HOLDER CASSAVA FARMERS IN SOUTH-EASTERN NIGERIA

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ABSTRACT
The Ordered Probit model analysis procedure was applied to determine the factors (related to fixed and variable transaction costs) influencing the decision to participate in cassava markets by a sample of 360 smallholder farmers in South-Eastern Nigeria. Participation decisions revealed that membership of cooperatives or social organizations, farming experience and marketing experience had a positive relationship with decision to be autarkic other than buyer and seller other than autarkic and significant at 1.0% level of probability. The coefficients for frequency of extension contacts, age, native of community, road conditions to the nearest town and yield were also positive and significantly related to decision to be autarkic other than buyer and seller other than autarkic at 5% level of probability. The coefficient for access to communication facilities was positive and significantly related to decision to remain autarkic other than buyer and seller other than autarkic. The coefficients for education, distance to the nearest town, distance from the farm to the market and crop transportation were negative and significantly related with the decision to remain autarkic other than a seller and buyer other than autarkic at 1% level of probability. The coefficient for gender was positive and significantly related to decision by female farmers to be autarkic other than buyer and seller other than autarkic. These decisions to participate as a buyer, seller or remain autarkic were as a result of fixed and proportional transaction costs associated with participating in the market.

Keywords: Ordered Probit, Transaction Costs, Market Participation and Cassava

INTRODUCTION

Fresh cassava roots, with about 70% water content, are bulky and therefore expensive to transport especially over long distances. The roots are also perishable, and begin to deteriorate soon after harvest. These features are expected to have profound bearing on the trade network for the roots. For instance, the bulky nature of the roots makes the market for fresh roots more localized around the producing areas than the market for processed cassava products. Also the perishability factor makes the marketing process considerably shorter for fresh roots than other cassava products (Ezedinma *et al*., 2007).

Cassava (*Manihot esculenta Crantz)* is an important staple food and cash crop in several tropical African countries especially Nigeria where it plays a principal role in the food economy (Agwu and Anyaeche, 2007). Nigeria is the world's largest producer of cassava, with about 47,274,320mt and yield of 13.027tonne/ha. The South-East zone is leading in

cassava production accounting for over 37% of the National production (NAERLS and NFRA, 2009).

In developing countries, smallholder farmers find it difficult to participate in markets because of a range of constraints and barriers reducing the incentives for participation, which may be reflected in hidden costs that make access to markets and productive assets difficult (Makhura *et al*., 2001). Transaction costs, that is, observable (variable) and non-observable (fixed) costs associated with exchange, are the embodiment of access barriers to market participation by resource poor smallholders (Holloway *et al*, 2000)

Households commonly incur fixed costs in making the decision to trade in a market. Such costs are known to exist irrespective of transactions volume and surely affect the decision about how much quantity to supply to the market noted by (Cogan, 1981) in a neo-classical model of labour supply. Yet the standard estimation of market supply equations fails to account for these fixed costs (Holloway *et al*., 2005). Hobbs (1997) classified fixed transaction costs into information, negotiation, and monitoring or enforcement costs. Fixed and variable transaction costs impact on market participation whereas supply decisions (amount sold), conditional on market participation, only depend on variable transaction costs.

If transaction costs are large, they need to be measured and explained. *de* Janvry and Sadoulet, (2005) have argued that attempting to observe them directly will always underestimate their importance, quite likely by large amounts. The study showed, however, that they can be derived from observed behaviour. Transaction costs reflect the character of the market, but are mainly embedded in household characteristics and their economic environment (Holloway *et al*., 2000 and Makhura, *et al*., 2001).). The objective of the paper is to identify factors that influence the decision of smallholder farmers to participate in cassava markets.

METHODOLOGY

(a) The Theoretical Model: The Ordered Probit model is a widely used approach to estimating models of ordered type which almost employs the probit link function. There is a latent continuous metric underlying the ordinal responses observed by the analyst. The

latent continuous variable, Y* is a linear combination of some predictors, X, plus a disturbance term that has a standard Normal distribution:

$$Y_i^* = X_i\beta + \varepsilon \quad (1)$$

The latent variable Y_i^* exhibits itself in ordinal categories, which could be coded as 0, 1, 2,…, k. The response of category k is thus observed when the underlying continuous response falls in the *k*-th interval as:

$$Y^* = 0 \text{ if } Y^* \leq \delta_0$$

$$Y^* = 1 \text{ if } \delta_0 < Y^* \leq \delta_1$$

$$Y^* = 2 \text{ if } \delta 1 < Y^* \leq \delta_2 \quad (2)$$

Where Y* (i=0, 1, 2) are the unobservable threshold parameters that will be estimated together with other parameters in the model. When an intercept coefficient is included in the model, Y_0^* is normalized to a zero value (Green, 2000) and hence only k-1 additional parameters are estimated with Xs. Like the models for binary data, the probabilities for each of the observed ordinal response which in this study had 3 responses (0, 1, 2,) will be given as:

$$\text{prob } (Y = 0) = P(Y^* \leq 0) = P(\beta'X + \varepsilon_i \leq 0) = \text{ø}(-\beta'X)$$

$$\text{prob } (Y = 1) = \text{ø}(\delta_1 - \beta'X) - \text{ø}(-\beta'X)$$

$$\text{prob } (Y = 2) = 1 - \text{ø}(\delta_1 - \beta'X) \quad (3)$$

where $0 < Y_1^* < Y_2^* < ... < Y^*_{k-1}$ …. n is the cumulative normal distribution function such that the sum total of the above probabilities is equal to one. The specification of the ordered probit model is as follows. Let *Y i* denote the category – net buyer (0 = *Y i*), autarkic (1 = *Y i*), or net seller (2 = *Y i*) – to which household *i* belongs.

(b) The Empirical Model: In this study, the market participation decision for cassava farmers is specified as follows;

$$I_i^{\text{sell or not}} = b_0 + b_1^{op}X_1^{op} + b_2^{op}X_2^{op} + b_3^{op}X^{op} + b_4^{op}X_4^{op} + b_5^{op}X_5^{op} + b_6^{op}X_6^{op} + b_7^{op}X_7^{op} + b_8^{op}X_8^{op} + b_9^{op}X_9^{op} + b_{10}^{op}X_{10}^{op} + b_{11}^{op}X_{11}^{op} + b_{12}^{op}X_{12}^{op} + b_{13}^{op}X_{13}^{op} + b_{14}^{op}X_{14}^{op} + b_{15}^{op}X_{15}^{op} + b_{16}^{op}X_{16}^{op} + b_{17}^{op}X_{17}^{op} + b_{18}^{op}X_{18}^{op} + b_{19}^{op}X_{19}^{op} + b_{20}^{op}X_{20}^{op} + b_{21}^{pr}X_{21pr} + b_{22}^{op}X_{22}^{op} + b_{23}^{op}X_{23}^{op} + b_{24}^{op}X_{24}^{op} + u_i^{op} \quad (4)$$

Where;

$I_i^{\text{sell or not}}$=Buyer = 0, Autarky = 1 and Seller = 2

X_1 is number of extension visits/year, X_2 is membership of cooperatives (dummy variable; I=member, 0=non member), X_3 is access to communication facilities (dummy variable; 1=yes, 0=no), X_4 is level of education (in years), X_5 is gender (dummy variable; 1=male, 0=female), X_6 is age of household head (in years), X_7 is native of community (dummy

variable; 1= native, 0 = otherwise), X_8 is farming experience (in years), X_9 is time to get paid (days), X_{10} is number of times asked for payment, X_{11} is personal means of transportation (dummy variable; 1=yes, 0=no), X_{12} is distance to nearest town (km), X_{13} is distance from the farm to the market (km), X_{14} is distance from the house to the market (km), X_{15} is distance from the house to the farm (km), X_{16} is amount of credit borrowed in Naira, X_{17} is crop transportation costs (Naira/tonne), X_{18} is household size, X_{19} is dependency ratio (the number of dependents below 18 and above 60 per household of working age), X_{20} is road conditions to nearest town (dummy variable; 1=good, 0=bad), X_{21} is marketing experience (in years), X_{22} is farm income in naira, X_{23} is non farm income in Naira, X_{24} is Cassava yield (kg/ha), $b_1 - b_{24}$ are coefficients to be estimated and u_i^{op} is error term.

(c) The Data: The South East Agro Ecological Zone of Nigeria was our main focus. The Zone lies between latitude 6° and 9°E and 4° and 7°N longitude, has a total land mass of 10,952,400ha. The zone has over 16 million resident populations (NPC, 2006). The zone is made up of five states viz: Abia, Anambra, Ebonyi, Enugu and Imo States. About 60-70% of the inhabitants engaged in agriculture, mainly crop farming and animal rearing. Three out of the 5 states in the South-East agricultural zone were randomly selected for the study. They were Anambra, Abia and Enugu States. A multi-stage randomised sampling procedure was used to collect cross sectional data to identify factors of market participation among cassava producing households. At the second stage two agricultural zones per state were randomly selected. They were; Enugu North and Enugu East for Enugu State, Anambra and Onitsha for Anambra State and Umuahia and Ohafia for Abia State given a total of six agricultural zones. In the third stage, two LGAs were randomly selected from each zone given a sample of 12 LGAs. In the fourth stage, three communities were selected randomly from each Local Government Area given a sample of 36 communities. In the last stage 10 household producers were randomly selected, given a total of 360. Data were collected by means of structured questionnaire to collect a range of information, which entails information about households regarding gender and age of the household head, size of the household, farm income and assets such as non-farm income, as well as transport equipment. Access to market information was collected in terms of average household education, contact with extension service and proximity to the nearest town where the markets are etc. The conditions of the roads to the markets were also determined, etc.

RESULTS AND DISCUSSION

Decision on Market Participation

The ordered probit model of discrete market participation is shown in table 1. The non-zero censoring points were of negative signs, with the lower censoring threshold at -1.63 cassava net purchases and the upper threshold at -0.94 cassava net sales, each statistically significantly different from zero. These estimates suggest that purchases or sales of less than 1kg are generally uneconomical. People were more willing to enter the market for smaller volume sales than purchases, likely reflecting the fact that sales of cassava are essentially means by which households meet immediate cash needs related to payment of school fees, food purchases and ceremonial or emergency health expenses (Bellemare and Barret, 2006). The goodness-of-fit measured by the chi^2 showed that the choice of explanatory variables included in the ordered probit model explained the variation in decisions to participate in the market.

All variables related to information and search costs were positive and significantly related to the categorical outcome except education which was negative. The coefficients for membership of cooperative societies and level of education were significant at 1.0% level of probability while access to communication facilities and frequency of extension contact were significant at 10.0% and 5.0% level of probability respectively. Farmers who have access to communication facilities, membership of cooperative societies with more frequency of extension contacts were more likely to be autarkic than buyers and were more likely to be sellers than to be autarkic, *ceteris paribus*. Farmers who were more educated were more likely to be autarkic than sellers and were more likely to be buyers than autarkic. Contact with extension officers tends to improve farmers' access to information (Lapar *et al.,* 2003). Access to information through extension, membership of cooperative societies, access to communication facilities and education tends to remove the fixed transaction costs facing the smallholder farmers in entering the cassava markets. The negative coefficient of education was contrary to the usual expectation. This suggests the strong competing effect of diverting skills to other off-farm employment opportunities as the level of education increases within the household in this particular data set.

Variables related to bargaining and negotiation costs that were significant were gender, age, native of community and farming experience.

Table 4.4: Results of Ordered Probit regression for Market Participation

Variable	Parameter	Coefficient	Std. error	t-value
Frequency of Extension Contact	b_1	0.0444	0.0181	2.4530**
Membership of Cooperatives	b_2	0.4098	0.1277	3.2091***
Access to Communication facilities	b_3	0.2641	0.1430	1.8468*
Level of Education(years)	b_4	-0.0116	0.0031	-3.7154***
Gender	b_5	-0.2518	0.0921	-2.7341**
Age (years)	b_6	0.0143	0.0049	2.9184**
Native of Community	b_7	0.0571	0.0211	2.7075**
Farming Experience (years)	b_8	0.0127	0.0021	5.9112***
Time to get paid in days	b_9	0.0150	0.0246	0.6097
Number of times asked for payment	b_{10}	-0.1242	0.2633	-0.4717
Have personal means of transport	b_{11}	0.1023	0.1963	0.5211
Distance to the nearest town (km)	b_{12}	-0.0326	0.0103	-3.1650***
Distance from the farm to the market (km)	b_{13}	-0.1852	0.0356	-6.0602***
Distance from the house to the market (km)	b_{14}	-0.0139	0.0300	-0.4618
Distance from the house to the farm (km)	b_{15}	0.0063	0.0283	0.2225
Volume of Credit (N)	b_{16}	-0.0070	0.0132	-0.5311
Cost of transportation (N/kg)	b_{17}	-0.0994 .	0.0218	-4.5596***
Household Size	b_{18}	-0.0099	0.0394	-0.2512
Dependency ratio	b_{19}	-0.0249	0.0561	-0.4438
Road conditions to the nearest town	b_{20}	0.3290	0.1309	2.5116**
Marketing Experience (years)	b_{21}	0.0039	0.0006	6.5394***
Farm income (N)	b_{22}	7.51e-07	6.55e-07	1.1465
Non farm Income (N)	b_{23}	-5.46e-07	9.13e07	-0.5980
Yield (kg/ha)	b_{24}	0.0013	0.0005	2.6069**
Ancillary Parameters				
c_1		-1.633072	0.1433	-11.4020***
c_2		-0.9436378	0.1138	8.2910***
Log likelihood		-327.29233		
chi^2		0.0000		

Survey Results 2010. *, ** and * = Significant at 10%, 5% and 1% respectively**

The coefficients for age and native of community were positive and significant at 5.0% level of probability, while gender was negative but significant at 5.0%. The coefficient for farming experience was positive and significant at 1.0% level of probability. Female-headed households who are natives were more likely to be autarkic than buyers and were more likely to be sellers than autarkic, *ceteris paribus*. Female-headed households have a greater likelihood of participation in cassava markets than male-headed households. This follows the study of Arega *et al.,* (2007) on maize markets in Kenya and Makhura, (2001)

on livestock markets in South Africa. Possibly because better sales bargain are made by women. The gender of the head of the household reflects the fact that female farmers will face lower transaction costs since they tend to have more credibility.

Respondents who were older were more likely to be autarkic than to be buyers and were more likely to be sellers than to be autarkic, *ceteris paribus*. This could be suggesting that fixed costs such as language barriers or discrimination may constrain the ability of non-indigenous or migrant farmers to integrate in some markets (Vakis *et al*., 2003). Experience (reflecting the ability to negotiate), increases farmers participation. The age of head of the household normally provides a proxy for experience in farming, Further, these farmers will have stronger social network and will have established credibility within the network (Makhura *et al*., 2001).

Among the variables for proportional transportation costs, the coefficients for distance to nearest town and distance from the farm to the market and crop transportation costs were negative and significant at 1.0%level of probability. The road conditions to the nearest town and yield were also positive but significant at 5.0% level of probability. Farmers with long distance to the nearest town and from the farm to the market as well as high cost of crop transportation costs were likely to be autarkic other than sellers and buyers other than autarkic. If road conditions to the nearest town were good and yield of cassava high, farmers were likely to remain autarkic other than buyers and sellers other than autarkic. Poor infrastructure also leads to a hike in crop transportation costs per km. The variable transactions cost will be reduced if the markets would be located closer to the farmers with good road networks.

The coefficients of the variables associated with monitoring and enforcement costs viz; time to get paid in days were positive and number of times asked for payment negative but not significant. The coefficients of volume of credit, distance from the house to the farm, house hold size dependency ratio and non-farm income were negative but not significant. The coefficients for farm income distance from the house to the market and have a personal means of transportation were positive but not significant.

CONCLUSION

The results support previous studies that existence of transaction costs constrains

households from selling. Collectively, these results demonstrate the importance of allowing for non-negligible fixed costs in market participation studies. Policies that reduce transaction costs through improved transportation and the promotion of organizations for marketing would increase market participation by participants. In addition, improving rural infrastructure (e.g., access roads) would facilitate faster delivery of farm produce (especially perishable commodities such as cassava) to urban consumers. Also, provision of rural employment opportunities is essential to reduce migration to urban centers. The transaction costs of participation could thus be reduced through improved information, transportation infrastructure and promotion of institutional innovations, such as production and marketing cooperatives.

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