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RESEARCH ARTICLE

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Determinants of farmer participation in direct marketing channels: A case study for cassava in the Oyo State of Nigeria

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Abstract

Improving rural farmers' access to direct agricultural markets is required to ensure sustainable supply of food. Rural farmers in the developing world account for the largest share of food supply including cassava. Globally, cassava (*Manihot esculenta* Crantz) is recognised as an important source of valuable semi-processed industrial raw materials such as ethanol, high-quality cassava flour and starch. However, there is less empirical research on rural farmers' participation in direct marketing channels in the cassava sector. This study focused on analysing the determinants of farmer participation in direct marketing channels using the case of the cassava sector in the Oyo State of Nigeria. The Bivariate Tobit model was applied in the empirical analysis, based on a primary dataset generated from 400 rural cassava farmers from the Oyo State of Nigeria. The result showed that, in general, farmers sold a higher percentage of their cassava output to processors. The Bivariate Tobit results showed that human capital, physical capital, social capital, and market conditions had significant effects on farmers' decisions on whether to sell their cassava output directly to processors or middlemen. On the contrary, natural and financial capitals did not significantly affect farmers' marketing channel decision. The study recommends that policy instruments should target improving road networks in rural areas, enhancing farmers' access to market information, and increasing membership of farmer association to ensure an active participation of farmers in the direct marketing channels.

Additional keywords: Bivariate Tobit; market participation; *Manihot esculenta* Crantz; 5-capital framework; rural development; econometrics; agricultural market.

Abbreviations used: ADZ (Agricultural Development Zone); SSA (sub-Saharan Africa); TV (Television); VIF (variance inflation factor).

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Introduction

Agriculture continues to play an important role in promoting economic development and enhancing the rural economy by providing numerous employment opportunities to many people in rural communities in sub-Sahara African (SSA) countries (Barrett, 2008). The agricultural sector also contributes to improving food and nutrition security in SSA countries through the supply of food commodities (Tadesse & Shively, 2013). Improved access to direct markets, notably peri-urban and urban markets is a necessary prerequisite to ensure a sustainable supply of food commodities. The marketing of agricultural products is a central component of the food value chain. Access to reliable and ready market serves as an incentive for producers to increase their farm outputs. However, in many SSA countries, the marketing of agricultural commodities remains a challenge for most smallholder producers (Umberger *et al.*, 2015). In Nigeria, the agricultural marketing system, especially the cassava (*Manihot esculenta* Crantz) market is characterised by poor coordination, information asymmetry, price fluctuation, and overexploitation of vulnerable producers (Adejobi & Adeyemo, 2012). The producers of cassava tubers have limited marketing options. They participate in

the agricultural output markets by either selling their cassava tubers directly to processors, who add value to the tubers by processing them into traditional food products such as *gari* and *lafun*, or depend on middlemen to perform their marketing function for them (Donkor *et al.*, 2017).

The main objective of this study was to analyse the effects of the determinants of farmer decision to either participate in the processor or middlemen marketing channels in the Oyo State of Nigeria. An empirical study on rural farmers' participation in the cassava marketing channels is relevant because the cassava sector in the Oyo State of Nigeria provides numerous employment opportunities to rural farmers and other actors. The cassava processing sector in Oyo State is rapidly expanding, and it requires a constant supply of cassava output. Therefore, it is necessary to ensure that farmers have access to this direct market to encourage them to increase their cassava outputs. More than 80% of the cassava tubers produced in Oyo State are consumed in various processed forms, namely *gari*, *lafun*, bread, fritter, cake, croquette, among others (Adejobi & Adeyemo, 2012; Donkor *et al.*, 2018). This evidence shows that the cassava sector contributes to improving sustainable food supply to feed the increasing population in the State. Furthermore, cassava can be regarded as an 'untapped treasure of Africa' because it is an important source of many valuable industrial raw materials such as starch, ethanol and high-quality cassava flour (Owusu & Donkor, 2012; Donkor *et al.*, 2018). These raw materials are used in the pharmaceutical, bakery and confectionery, textile, brewery and biofuel industries. These benefits associated with cassava justify the relevance of the present study.

Extant empirical studies have found that a number of factors influence farmers' participation in agricultural markets (Bellemare & Barrett, 2006; Alene *et al.*, 2008; Shilpi & Umali-Deininger, 2008; Barrett, 2008; Tadesse & Shively, 2013; Mather *et al.*, 2013; Tedesse & Bahiigwa, 2015; Aker & Ksoll, 2016). For instance, Alene *et al.* (2008) observed that farmer access to extension services, household size, ownership of livestock, the price of maize output and group marketing significantly increased the supply of maize to the market whereas long distance to maize market reduced the supply of maize output to the Kenyan maize market. On the other hand, Mather *et al.* (2013) identified, that among other things, landholding, farmer age, main season drought shocks, ownership of a radio set and a cart were the key determinants of farmer participation in the maize market in Kenya. In Ethiopia, Tedesse & Bahiigwa (2015) analysed the effect of mobile phones on marketing decisions of farmers. This study concluded that the farmers who had access to mobile phones tended to sell their farm outputs to the village market. Enete & Igbokwe (2009) evaluated the cassava market participation decision of farm households in Uganda, Tanzania and Côte d'Ivoire; they found that short market distance and access to market information increased the market participation among cassava producing households in these African countries. Adejobi & Adeyemo (2012) showed that gender and access to market information enhanced farmers' probability to participate in the cassava market in Nigeria. It was observed that there were few extant studies on farmer participation in the cassava markets, particularly the direct and indirect markets. The few studies on cassava (Enete & Igbokwe, 2009; Adejobi & Adeyemo, 2012) tended to consider a limited number of factors that influenced cassava market participation in Nigeria.

The present study improves our understanding on the determinants of farmer participation in direct or indirect marketing channels by inculcating different capital variables, namely human, physical, financial and social in the analysis of farmer participation in the marketing channels. These factors could enable policymakers and stakeholders to formulate robust policy frameworks that provide an enabling business environment and facilitate the marketing transaction of smallholder farmers in rural communities in the Oyo State of Nigeria and other cassava producing States in Nigeria. Improved market conditions would encourage farmers to increase their production scale; generate enough incomes and consequently promote rural economic development.

Material and methods

Theoretical framework

Cassava is a cash crop, so all the cassava farmers included in the study participate in the market. For this reason, the study did not generally focus on the binary decision of whether to participate in the market or not. Instead, it specifically concentrated on farmer participation in the cassava marketing channels, namely the middlemen and processor marketing channels. For the purpose of this study, farmer participation was operationalised as the proportion (percentage) of the marketed surplus (defined as the total harvested cassava output minus the volume consumed by farmers) supplied to each of the marketing channels.

In the processor marketing channel, farmers sell cassava tubers directly to processors without any intermediary. This enables farmers to negotiate the price directly with processors. Farmers search for

buyers before they harvest because cassava tubers are highly perishable. Cassava farms are little far from the processing sites; therefore, farmers transport cassava tubers to processors who are located in nearby peri-urban areas. In contrast, in the middlemen marketing channel, farmers sell cassava output to middlemen who usually transport cassava tubers and negotiate the price with processors. Processors add value to the cassava tubers by processing them into traditional food products such as *gari, fufu* and *lafun*. Processors sell the processed products either to the wholesalers or retailers, who deliver the products to the final consumers in peri-urban and urban areas.

The theoretical foundation of the study is based on the theory of rational choice. The rational choice theory states that an economic agent seeks to select a choice that maximises his/her utility subject to some constraints (Ward, 1995). Based on this theory, the study assumes that a farmer decides to intensify his/her participation in a marketing channel that offers the highest profit margin taking into consideration the associated transaction costs. The farmer is likely to increase their sale of cassava output directly to processors if the expected profit margin (U_p) exceeds the expected profit margin (U_m) derived from selling to middlemen, thus, $U_p - U_m > 0$ or $U_p > U_m$. On the other hand, the farmer tends to supply more cassava output to middlemen if the expected profit margin generated is greater than the expected profit margin from the sale to processors. This simultaneous choice problem is addressed with the Bivariate Tobit model, where one equation is estimated for the middlemen marketing channel and another equation for the processor marketing channel (Bellemare & Barrett, 2006). Following Bellemare & Barrett (2006) and Chena & Zhou (2011), the Bivariate Tobit model is theoretically specified as in equations (1) to (3):

$$Y_{1i}^{*} = \Gamma_1 X_{i1} + \tau_{1i} \quad (1)$$

$$Y_{1i} = Maximum(Y_{1i}^{*}, 0) = \begin{cases} Y_{1i}^{*}, & if\ Y_{1i}^{*} > 0 \\ 0, & if\ Y_{1i}^{*} \leq 0 \end{cases} \quad (2)$$

$$Y_{2i}^{*} = \Gamma_2 X_{i2} + \tau_{2i} \quad (3)$$

$$Y_{2i} = Maximum(Y_{2i}^{*}, 0) = \begin{cases} Y_{2i}^{*}, & if\ Y_{2i}^{*} > 0 \\ 0, & if\ Y_{2i}^{*} \leq 0 \end{cases} \quad (4)$$

where Y_{1i}^{*} and Y_{2i}^{*} represent the unobservable dependent variables, Y_{1i} and Y_{2i} denote the dependent variables representing the proportion (percentage) of cassava tubers sold to processors or middlemen, respectively; $\boldsymbol{X}$ is a set of observable exogenous variables, Γ_{1i} and Γ_{2i} indicate a vector of parameters to be estimated; τ_{1i} and τ_{2i} are the error terms which are assumed to have a bivariate normal distribution, thus, $\tau_{1i}, \tau_{2i} : N(0,0,\rho_1^2,\rho_2^2,\rho_{12})$, where ρ_{12} is the correlation between the error terms τ_{1i} and τ_{2i}. The distributions are independent if and only $\rho_{12}=0$. This condition is tested using the likelihood ratio test. The parameters in equations (1) and (2) are estimated simultaneously using the maximum likelihood estimation approach by following Chen & Zhou (2011):

$$L = \prod_0 \left[1 - \Phi(\Gamma_k X_k / \sigma)\right] \prod_1 \sigma^{-1} \left[\phi(Y_{ik} - \Gamma_k X_k / \sigma)\right] \quad (5)$$

where L is the likelihood estimate, $Y_k = \{Y_{1i}, Y_{2i}\}$, $X_k = \{X_{1i}, X_{2i}\}$, $\Gamma_k = \{\Gamma_{1i}, \Gamma_{2i}\}$, σ is the standard deviation of the normally distributed latent variable Y_k^{*}, where $Y_{ki}^{*} = \{Y_{1i}^{*}, Y_{2i}^{*}\}$, Φ is the cumulative standard normal distribution function, and ϕ is the standard normal density function.

The coefficients of the Tobit model do not have a direct interpretation because they represent the effects of the independent variables on the latent dependent variables (Leclere, 1994). Following Leclere (1994), the marginal effects which represent the effects of the explanatory variables on the expected value of the dependent variables for all observations are provided as:

$$\frac{\partial E(Y)}{\partial X_i} = \Phi[\partial E(Y^{*}) / \partial X_i] + [\partial E(Y^{*}) - k][\partial \Phi / \partial X_i] \quad (6)$$

where

$$E(Y) = \mathbf{X}\Gamma\Phi - \sigma\phi + k(1-\Phi),\ \frac{\partial E(Y^{*})}{\partial X_i} = \Gamma_i - \frac{\sigma}{\Phi}\frac{\partial \phi}{\partial X_i} + \frac{\phi}{\Phi^2}\frac{\partial \Phi}{\partial X_i},\ \frac{\partial \phi}{\partial X_i} = \frac{\Gamma_i}{\sigma} z\phi,$$

$$E(Y^{*}) = \mathbf{X}\Gamma - \sigma\phi/\Phi \text{ and } \frac{\partial \Phi}{\partial X_i} = \frac{-\Gamma_i}{\sigma}\phi$$

k denotes an upper limit of the Tobit model, z is the z-score for an area under the normal curve, σ is the standard deviation of the error term.

Following the 5-capital framework proposed by Donovan & Stoian (2012) to achieve sustainable human development and empower rural communities to improve their livelihoods (Diaz-Puente *et al.*, 2009), the present study classifies the determinants of farmer participation in either the processor or middlemen marketing channels into six main categories: human capital, natural capital, physical capital, financial capital, social capital and market conditions.

Human capital entails aptitudes, knowledge, work capacities and health that together enable people to carry out different strategies to reach their objectives regarding livelihoods (Barrera-Mosquera *et al.*, 2010). The human capital variables included in the study are farmer gender, age, household size, experience, educational level and labour input. The current study expects that farmer gender, age and household size

could exert negative effects on the volume of cassava output supplied to processors. Farmers with large households, especially if the percentage of dependents are high, tend to face budget constraints, so they are unable to bear the extra costs to transport cassava tubers to processors. This tends to reduce their probability to intensify the supply of cassava output to processors. It is also expected that educational level and labour input precipitate positive effects on the proportion of cassava output sold to processors. The reason is that education tends to improve the cognitive and managerial skills of farmers which enable them to easily retrieve and process relevant market information and use it to make an informed market decision. Educated farmers tend to take a calculated risk of bearing the transaction costs and increase the proportion of cassava output sold to processors. In addition, the availability of cheap labour input tends to stimulate farmers to increase the supply of cassava output to processors, since labour input is needed to transport cassava tubers to the nearest main road that leads to processing sites.

Natural capital is the natural resources that are essential for sustainable livelihood (Flora *et al.*, 2004). The natural capital variable includes only land area under cassava production. It is expected that farmers who have large cassava farms are more likely to intensify the supply of cassava tubers to processors. These farmers tend to face less resource constraint and can bear the associated transaction costs of supplying cassava outputs to processors.

Physical capital refers to the basic infrastructure that facilitates productive, reproductive and social activities of a community (Flora *et al.*, 2004). The physical capital considered in the study are ownership of a mobile phone, a radio set, a television (TV) set, a vehicle, a motorbike and access to electricity. It is expected that farmers' ownership of these physical assets will influence their decisions to increase the percentage of cassava output sold to processors. The reason is that the communication assets (specifically, mobile phones, radio sets and TV sets) serve as an important source of market information for farmers. They also enable farmers to search for processors in nearby peri-urban centres. The transport assets help farmers to overcome the difficulty in delivering cassava output to processors.

Financial capital comprises economic resources that are deployed for investment before being used for consumption. They include farmer access to credit and participation in an off-farm activity. The study expects that these financial capital variables will enhance farmers' probability to increase the volume of cassava output sold to processors. Farmers' access to these financial capital factors tends to increase their financial resources which allow them to bear the transaction costs associated with the participation in the processor marketing channel.

Social capital refers to the interactions, connections, and relationships between individuals and communities (Carney, 1998). Membership of farmer associations, farmer access to extension services and location variables are classified as social capital in this study. It is expected that membership of farmer associations and access to extension services exert positive effects on the percentage of cassava output sold to processors. The reason is that members of farmer associations can share information on the prevailing market price and available processors in the nearby peri-urban communities. Also, extension officers tend to provide relevant market information to farmers. These benefits of membership of farmer associations and access to extension services tend to influence farmers' decisions to intensify their participation in the processor marketing channel. It is expected that farmers who are located in communities which are closer to cassava processing sites are more likely to increase the proportion of their cassava tubers sold to processors.

Market conditions are the factors that facilitate market transactions, and they include the price of cassava tubers, farmer access to market information, good road network and transportation costs. The study expects that the price of cassava tubers per tonne, access to market information and good road network exert positive effects on the percentage of cassava output supplied to processors. An increase in the price of cassava tubers per tonne tends to stimulate farmers' probability to increase the volume of cassava sold to processors. This maintained hypothesis holds if the price offered by processors can help farmers to generate an extra high income after accounting for the transaction costs. Market information and access to good road network enable farmers to increase their volume of trade with processors. However, an increase in transportation costs tends to discourage farmers from participating in the distant market. This is because transportation costs increase their transaction costs as well as their total production costs which consequently decrease their profit margins. The relationships between farmer participation in the cassava marketing channels and the relevant explanatory variables are presented in Figure 1. This conceptual framework guides the estimation strategy for the Bivariate Tobit model.

Empirical model specification

Based on the theoretical foundation, the empirical models employed to analyse the factors that influence the proportion of cassava tubers sold to processors or middlemen are specified as in (7):

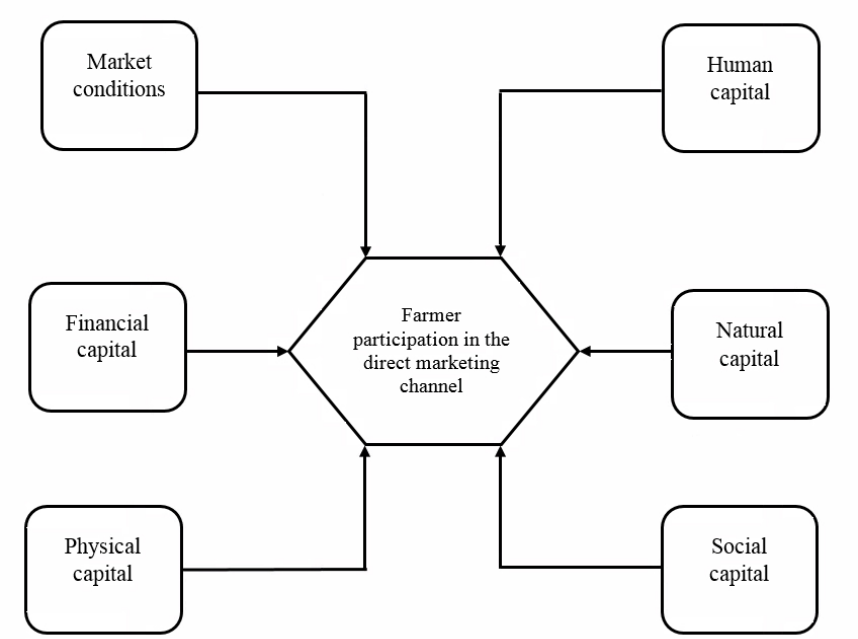

Figure 1. 5-capital market-based conceptual framework. *Source:* Authors' design, 2016.

$$EMP_{ik} = \Gamma_{0k} + \sum_{i=1}^{8} \Gamma_{jk} Humancapital_{ijk} + \Gamma_{9k} Naturalcapital_{ijk} + \\ + \sum_{j=10}^{15} \Gamma_{jk} Physicalcapital_{ijk} + \sum_{j=17}^{16} \Gamma_{jk} Financialcapital_{ijk} + \\ + \sum_{j=18}^{22} \Gamma_{jk} Socialcapital_{ijk} + \sum_{j=23}^{26} \Gamma_{jk} Marketcondition_{ijk} + \tau_{ik} \quad (7)$$
$$j = 1\ (processors),\ 2\ (middlemen)$$

where EMP_{ij} refers to the proportion (percentage) of cassava tubers sold to the middlemen or processor marketing channels. $Humancapital_{ijk}$ represents a set of human capital variables related to the cassava farmer: farmer's gender, age, household size, experience in cassava farming, educational level and labour input. *Gender* is measured as a dummy variable, 1 if the farmer is a male and 0 otherwise. *Age* is the age of the farmer in years. *Household size* represents the number of people in the farm household. *Experience* is the number of years that the farmer has been cultivating cassava. *Educational level* is captured as a categorical variable, namely no education, primary, secondary and tertiary. Each of these educational variables is included in the models as a dummy variable, and no formal education is used as the base category. *Labour* is the total quantity of labour input (in man-days) employed by farmers in their cassava farming business. Both family and hired labour inputs are aggregated. Man-day is computed as the number of people multiplied by the number of days used in undertaking farming various activities.

$Naturalcapital_{ijk}$ denotes natural capital variable which includes only land. The land variable is measured as the land area under cassava cultivation (hectares).

$Physicalcapital_{ijk}$ is the set of physical capital variables: farmer ownership of a mobile phone, a radio set, a TV set, a vehicle, a motorbike and access to electricity. Each of these variables is measured as a dummy variable. *Radio* equals 1, if the farmer owns a radio set and 0 otherwise; *TV* denotes 1, if the farmer has a television set and 0 otherwise; *Electricity* equals 1, if the farmer has access to electricity power supply and 0 otherwise; *Mobile phone* equals 1, if the farmer owns a mobile phone and 0 otherwise; *Vehicle* denotes 1, if the farmer has a vehicle and 0 otherwise; *Motorbike* denotes 1, if the farmer has a motorbike and 0 otherwise.

$Financialcapital_{ijk}$ is the set of variables under financial capital, namely farmer access to credit and engagement in an off-farm activity. *Credit* is measured as a dummy variable, 1 if the farmer has access to credit and 0 otherwise; *Off-farm activity* denotes 1, if the farmer participates in an off-farm activity and 0 otherwise.

$Socialcapital_{ijk}$ is a bundle of social capital variables: membership of farmer associations, farmer access to extension services and location variables. *Farmer association* denotes 1, if the farmer is a member of farmer association or group and 0 otherwise; *Extension* equals 1, if the farmer has access to extension services and 0 otherwise. The location variables are the four agricultural development zones: Ibadan/Ibarapa, Oyo, Ogbomosho and Saki. These variables are included in the models as dummy variables and Ibadan is used the base category.

$Marketcondition_{ijk}$ is the vector of variables that represents market conditions. These variables include the price of cassava tubers, farmer access to market information, the nature of road infrastructure and transportation costs. The price of cassava and transportation costs are measured as continuous variables. *The price of cassava tubers* is the price of cassava tubers per tonne (naira[1] per tonne); *Transportation cost* represents the total costs (in naira) associated with the transportation of cassava tubers to market centres or buyers; *Market information* denotes 1, if the farmer has access to market information (on price, buyer or market) and 0 otherwise; *Road infrastructure* indicates the nature of road from the community where the cassava farm is located to the market centre (if the road is tarred, it is coded 1 and 0 otherwise); $\Gamma_{0k},...,\Gamma_{27k}$ denote the parameters to be estimated; and τ_{ik} indicates the error term. All the continuous explanatory variables, namely farmer age, household size, experience, labour input, land, the price of cassava tubers and transportation costs are transformed into natural logarithms whereas the dependent variables are not transformed into natural logarithm. For this reason, the marginal effects of these variables are interpreted as the absolute change in the dependent variables due to a relative percentage change in the respective explanatory variable. In the empirical estimation of cross-sectional data, multicollinearity and heteroskedasticity problems are usually encountered. These issues tend to generate biased estimates which may result in a misleading conclusion (Gujarati, 2004). The present study would perform diagnostic tests using the variance inflation factor (VIF) and the Breusch-Pagan/Cook-Weisberg to check the presence of multicollinearity and heteroskedasticity in the model.

Source of data

Nigeria is located in West Africa with a total geographical area of 923,768 km^2 and a population of 170 million people. About 71.2 million hectares of the land area are cultivable but 34.2 million hectares (about 48% of the cultivable area) are being cultivated, and less than 1% of the arable land is irrigated (AfDB, OECD & UNDP, 2016). For administrative purposes, the country is divided into 36 states as shown in Figure 2.

The study was conducted in the Oyo State which is one of the States known for cassava production in Nigeria. Cassava farming serves as an important livelihood option for farmers in the Oyo State. This makes it necessary to collect a primary dataset from cassava farmers to analyse the determinant of their participation in the direct or indirect marketing channels. Oyo State has a total land size of 488,628 km^2 with a population of 6,617,720 people (AfDB, OECD & UNDP, 2016). Oyo State has been divided into 33 local government areas. For agricultural purposes, these local government areas are grouped into four main agricultural development zones, namely Ibadan/Ibarapa, Saki, Ogbomosho and Oyo.

A multi-stage cluster sampling technique was employed in the selection of cassava farmers from the study area. The first stage involved a random selection of four (4) local government areas from each cluster. In the second stage, one (1) community known for cassava

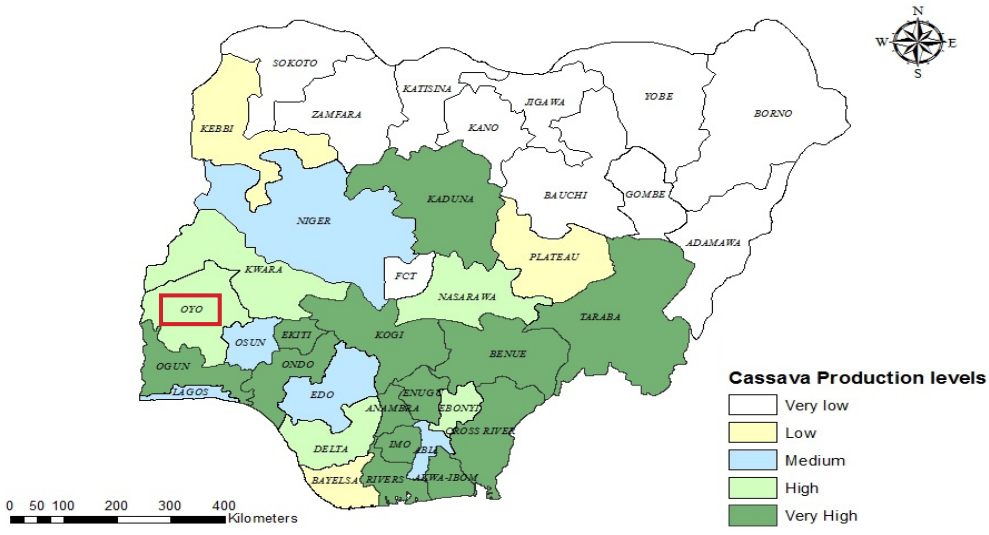

Figure 2. Map of Nigeria, divided in 36 states. *Source:* Google Maps (2016).

[1]Naira is the currency of Nigeria.

production was purposively selected from each local government area. This suggests that four (4) cassava-producing communities were selected from each stratum. The last stage involved a random selection of 25 farmers from each community with the assistance of a sample frame (a list of registered cassava farmers in the community) from the agricultural development directorate in the State. In total, 100 cassava farmers were selected from each cluster. This gave a total sample size of 400 cassava farmers. A structured questionnaire was used to collect the data from cassava farmers.

Results

Data

Table 1 presents means and standard deviations of the volume of total harvested cassava output, total consumption and marketed surplus. The mean volume of cassava tubers harvested by farmers in a year was 35.8 tonnes (Table 1). The survey data also indicates that cassava farmers consumed 3.6 tonnes (10.1%), whereas the remaining 32.2 tonnes (89.9%) was sold. On average, farmers sold 19.6 tonnes (60.9%) of their marketed surplus to processors while 12. 6 tonnes (39.1%) were sold to middlemen.

Table 2 shows the means and standard deviations of the relevant explanatory variables included in the Bivariate Tobit model. Table 2 indicates that 77.2% of the farmers who sold their cassava tubers to processors were males whereas 22.8% were females. Similarly, the majority (88.1%) of farmers who sold their cassava tubers to middlemen were males. These results suggested that male farmers were more involved in the production of cassava than female farmers. The mean age was similar for farmers who sold their cassava output to processors and middlemen (Table 2). The average household sizes for farmers who supplied cassava tubers to processors and middlemen were 7 people for both groups. The mean difference of household size (-0.46) was not statistically significant at $p>0.10$. It was also observed that 68.5% of farmers who traded with processors engaged in an off-farm activity whereas, in the case of middlemen, 61.5% participated in an off-farm activity. The mean difference (7%) for the off-farm activity variable showed statistical significance at $p>0.10$. The mean difference of experience for users of processors and middlemen was not statistically different from zero at $p>0.10$.

Regarding the levels of education, Table 2 shows that 27.8% of the users of the processor marketing channel had attained primary education whereas 33.6% of the users of the middlemen marketing channel had completed primary education. The mean difference of primary education showed statistical significance at $p>0.10$, implying that farmers with primary education were likely to trade a large quantity of their cassava tubers with middlemen. In contrast, the percentage of users (39.5%) of the processor marketing channel who had secondary education was higher than that of users of the middlemen marketing channel (30.3%) (Table 2). The mean difference of secondary education (9.2%) was statistically significant at $p>0.05$. Moreover, the mean differences of land and labour inputs used by users of the processor and middlemen marketing channels were not statistically different from zero even at $p>0.10$. Table 2 further indicates that the mean differences for the location variables were statistically different from zero at $p>0.05$.

In addition, 73.5% of users of the processor marketing channel belonged to farmer associations whereas only 49.4% of the users of middlemen channel were members of farmer associations (Table 2). The mean difference of farmer association was statistically significant ($p>0.01$). The survey data also reveal that the majority of the users of the processor marketing channel owned communication assets such as a radio set, a TV set and a mobile phone. The mean differences of ownership these communication assets for users of processors and middlemen were statistically different from zero ($p>0.01$); 94.4% of users of the processor marketing channel had access to market information on

Table 1. Means and standard deviations (SD) of the volume of cassava tubers sold and consumed by cassava farmers in 2016.

Variable	Mean (tonnes)	SD	%
Total volume of cassava tubers harvested	35.828	31.62	
Total volume of cassava tubers consumed	3.623	3.342	10.110
Total volume of cassava tubers sold (marketed surplus)	32.205	28.860	89.890
Total volume of cassava tubers sold to processors	19.620	26.580	60.922
Total volume of cassava tubers sold to middlemen	12.585	21.761	39.078

Source: Authors' estimations based on the survey data, 2016.

Table 2. Means and standard deviations of the variables included in the Bivariate Tobit model.

Variable	Processor channel (N=162)		Middlemen channel (N=122)		Mean difference	t-value
	Mean	SD	Mean	SD		
—*Human capital*						
Gender (Male)	0.772	0.421	0.811	0.393	-0.039^{NS}	-1.354
Age	47.827	12.528	48.943	14.197	-1.116 ^{NS}	-1.178
Household size	6.827	2.923	7.287	4.201	-0.46	-1.088
Experience	19.667	12.781	20.959	12.994	-1.292 ^{NS}	-1.417
Primary	0.278	0.449	0.336	0.474	**-1.776***	-0.058
Secondary	0.395	0.490	0.303	0.462	**0.092****	2.732
Tertiary	0.123	0.330	0.164	0.372	**-0.041***	-1.649
Labour input	40.312	14.711	39.365	14.184	0.946 ^{NS}	0.545
—*Natural capital*						
Land	2.582	1.989	2.384	1.681	0.198 ^{NS}	0.887
—*Social capital*						
Farmer association	0.735	0.443	0.410	0.494	**0.325*****	9.795
Extension	0.265	0.443	0.320	0.468	-0.055 ^{NS}	-1.707
Ogbomosho	0.253	0.436	0.328	0.471	**-0.075****	-2.337
Oyo	0.259	0.440	0.123	0.330	**0.136*****	4.945
Saki	0.290	0.455	0.205	0.405	**0.085*****	2.790
—*Financial capital*						
Credit	0.105	0.307	0.107	0.310	-0.002 ^{NS}	-0.0917
Off-farm activity	0.685	0.466	0.615	0.489	**0.07****	2.073
—*Physical capital*						
Radio set	0.889	0.315	0.328	0.471	**0.561*****	19.801
TV set	0.846	0.362	0.467	0.501	**0.379*****	12.263
Mobile phone	0.901	0.299	0.730	0.446	**0.171*****	6.369
Electricity	0.772	0.421	0.525	0.501	**0.247*****	7.548
Vehicle	0.148	0.356	0.033	0.179	**0.115*****	5.772
Motorbike	0.463	0.500	0.156	0.364	**0.307*****	9.928
—*Market conditions*						
Market information	0.944	0.230	0.582	0.495	**0.362*****	13.264
Tarred road	0.253	0.436	0.197	0.399	**0.056***	1.895
Price of cassava tubers/tonne	11,910.67	3,081.559	9,307.098	3,279.111	**2,603.572*****	11.572
Transport cost/tonne	1,144.332	3,515.324	569.837	580.735	**574.495*****	3.225

***, **, and * denote $p>0.01$, $p>0.05$, and $p>0.10$ statistical significance, respectively. NS: not statistically significant. *Source:* Authors' estimations based on the survey data, 2016. Exchange rate as at 27 October 2016 was US $1=₦314.75.

price and buyers, whereas 49.5% of users of middlemen marketing channel had access to market information (Table 2). The mean difference (36.2%) of access to market information between the two categories of farmers was statistically significant ($p>0.01$). This result indicated that cassava farmers who traded with processors were better informed regarding the price and the potential buyers of cassava tubers.

Generally, Table 2 shows that a low proportion of cassava farmers had better road networks connecting their communities to the peri-urban and urban marketing centres. However, a higher percentage (25.3%) of users of the processor marketing channel had good road networks whereas that of the users of middlemen was 19.7%. The mean price per tonne of cassava tubers offered by processors and middlemen were ₦11,910.7 (US$ 37.8) and ₦9,307.098 (US$ 29.6), respectively (Table 2). The mean difference of price per tonne of cassava tubers offered by processors and middlemen was ₦2,603.6 (US$ 8.3), and it was statistically significant

(p>0.01). This result indicated that processors tended to give a higher price to farmers than middlemen. In terms of transportation costs, farmers incurred ₦1,144.3 (US$ 3.6) to transport a tonne of cassava tubers to processors whereas, in the case of middlemen, farmers spent ₦580.7 (US$ 1.8). The mean difference of transportation costs between users of the processor and middlemen marketing channels was ₦574.495 (US$ 1.8) and it was statistically different from zero at p>0.01 (Table 2). Processors were mostly located in peri-urban and urban areas, and farmers needed to transport cassava tubers to them. Farmers sold cassava tubers to either middlemen at the farm gate or conveyed them from farms to their villages where cassava tubers were purchased by middlemen. The survey data show that a low percentage of cassava farmers owned a vehicle. However, the percentage of users of the processor marketing channel who owned a vehicle was higher than that of the users of middlemen. Similarly, Table 2 shows that 46.30% of users of the processor marketing channel had a motorbike whereas 36.40% of users of the middlemen marketing channel owned a motorbike. These results showed that a higher proportion of farmers owned a motorbike relative to a vehicle. This was because motorbikes were cheaper than vehicles. Besides cost, it was more convenient for farmers to use motorbikes to transport their harvested cassava tubers from the farm to the market than the use of vehicles. This was mainly because of the poor nature of road networks linking farms to communities and market centres.

Determinants of farmer participation in the cassava marketing channels

Table 3 shows that the mean VIF for all variables and the overall mean VIF (1.460) were less than 10. Gujarati (2004) suggested that if the mean VIF is less than 10, it implies that there is a low correlation among the explanatory variables. It was evident from the empirical results that the explanatory variables showed their expected signs and exhibited statistical significance. These were an indication that multicollinearity was absent in the model. The chi-square statistic (1.820) of the Breusch-Pagan/ Cook-Weisberg test was not statistically significant at p>0.10, implying that heteroskedasticity was not a concern in the model (Table 3).

The results from the Bivariate Tobit model on farmer participation in the cassava markets are presented in Table 4. The diagnostic statistic in Table 4 shows that the chi-square statistic (χ^2=557.311, df=27) of the likelihood ratio test of ρ_{12}=0 was statistically significant (p>0.01). This result showed that the proportion of cassava output sold to the different marketing channels was a joint decision which justified the application of the Bivariate Tobit model in the empirical analysis. Recall that the independent variables were measured as the proportion (percentage) of cassava tubers sold to either processors or middlemen. All the continuous variables, namely farmer age, cassava farming experience, household size, labour input, the price of cassava tubers, transportation costs and land area were transformed into natural logarithm. Therefore, their corresponding marginal effects were interpreted as the effects of percentage changes in those variables on the dependent variables. The coefficients represent the partial derivatives of the latent dependent variables with respect to the explanatory variables. These partial derivatives did not give information regarding the marginal effects related to the observed dependent variables. Therefore, the marginal effects were computed and discussed instead of the estimated coefficients.

Human capital variables

Two variables, specifically farmer gender and household size under human capital showed statistical significance on farmer participation in the processor and middlemen marketing channels (Table 4). Table 4 indicates that the coefficient and marginal effect of gender exerted significant positive effects on the proportion of cassava output sold to middlemen at p>0.01 and p>0.05, respectively, whereas they exhibited negative significant effects on the proportion of cassava output sold processors at p>0.05 and p>0.01, respectively. The marginal effect of 12.1 showed that male farmers were likely to increase the proportion of cassava output sold to middlemen by 12.1%. On the contrary, the result suggested that male farmers were likely to decrease the proportion of their cassava output supply to processors by 13.3% greater than that of female farmers (Table 4).

The coefficients and marginal effects of age were not statistically different from zero at p>0.10 in the middlemen and processor marketing channels' models (Table 4). This result suggested that farmers' age did not influence their participation in the middlemen or processor marketing channels.

Moreover, the coefficients and marginal effects of household size were positively associated with farmer participation in the middlemen marketing channel at p>0.01 and p>0.01, respectively (Table 4). The significant marginal effect showed that one-percentage-point increase in the farmers' household size tended to influence their decisions to increase the proportion of cassava output sold to middlemen by 1.0%. In the case of the processor marketing

Table 3. Tests for multicollinearity and heteroskedasticity.

Variable	VIF	Tolerance (1/VIF)
Secondary education	3.340	0.300
Tertiary education	2.200	0.454
Primary education	2.060	0.485
Age of the farmer (log)	1.890	0.528
Ogbomosho	1.750	0.571
Cassava farming experience (log)	1.730	0.578
Saki	1.720	0.582
Oyo	1.700	0.587
Ownership of TV set	1.310	0.765
Membership of farmer association	1.290	0.776
Access to electricity	1.280	0.782
Access to market information	1.280	0.782
Ownership of radio set	1.270	0.787
Engagement in an off-farm activity	1.190	0.839
Gender (Male)	1.190	0.842
Ownership of mobile phone	1.180	0.845
Household size (log)	1.180	0.848
Access to extension service	1.180	0.849
Ownership of motorbike	1.170	0.858
Nature of road (Tarred road)	1.150	0.871
Access to credit	1.140	0.881
Labour (log)	1.130	0.886
Price (log)	1.110	0.902
Transport cost (log)	1.100	0.911
Ownership of vehicle	1.090	0.920
Land area under cassava production (log)	1.070	0.935
Mean VIF	1.460	
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		
χ^2 (1) statistic	1.820^{NS}	
Probability>χ^2	0.177	

VIF: variance inflation factor. NS: not statistically significant. *Source:* Authors' estimations based on the survey data, 2016.

channel equation, the coefficient and marginal effect of household size exerted significant negative effects at p>0.10 and p>0.10, respectively. The significant marginal effect of -0.9 implies that one-percentage-point increase in the farmers' household size tended to reduce the percentage of their cassava output sold to processors by 0.9%.

The results in Table 4 further indicated that the coefficients and marginal effects of educational levels, cassava farming experience and labour input exhibited no significant effects on the percentage of cassava output sold to middlemen or processors at p>0.10. This result implied that these variables did not affect farmer decision to participate in the middlemen or processor marketing channels.

Natural capital variables

The coefficients and marginal effects of land did not show significant effects on the percentage of cassava output sold to middlemen or processors at p>0.10 (Table 4). This finding suggested that land area under cassava production tended not to influence the farmers' decisions regarding the participation in the cassava marketing channels.

Table 4. Bivariate Tobit model estimates of the determinants of farmer participation in the processor and middlemen marketing channels (standard errors in parenthesis).

Variable	Parameter	Middlemen channel		Processor channel	
		Coefficient	Marginal effect	Coefficient	Marginal effect
Constant	Γ_{0k}	91.4 ^{NS} (113.955)		40.576 NS (102.576)	
—*Human capital*					
Gender (Male)	Γ_{1k}	**15.008*** (6.470)**	**12.090** (4.807)**	**-14.698** (5.805)**	**-13.294*** (4.794)**
Age of farmers (log)	Γ_{2k}	0.112 ^{NS} (0.249)	0.115 ^{NS} (0.186)	0.0705 ^{NS} (0.224)	0.043 ^{NS} (0.195)
Household size (log)	Γ_{3k}	**1.679*** (0.592)**	**1.072*** (0.505)**	**-0.929* (0.535)**	**-0.869* (0.542)**
Experience (log)	Γ_{4k}	-0.176 ^{NS} (0.365)	-0.104 ^{NS} (0.186)	0.063 ^{NS} (0.323)	0.026 ^{NS} (0.194)
Primary	Γ_{5k}	5.156 ^{NS} (8.124)	4.542 ^{NS} (5.703)	-5.750 ^{NS} (7.256)	-7.619 ^{NS} (5.900)
Secondary	Γ_{6k}	-7.458 ^{NS} (8.995)	-5.728 ^{NS} (6.771)	10.882 ^{NS} (8.301)	8.469 ^{NS} (7.213)
Tertiary	Γ_{7k}	-0.901^{NS} (14.489)	-0.375 ^{NS} (7.655)	5.626 ^{NS} (12.683)	0.950 ^{NS} (8.484)
Labour (log)	Γ_{8k}	4.996 ^{NS} (8.907)	2.564 ^{NS} (6.356)	-0.799 ^{NS} (7.941)	-2.404 ^{NS} (6.536)
—*Natural capital*					
Land (log)	Γ_{10k}	1.070 ^{NS} (6.589)	0.740 ^{NS} (4.937)	0.286 ^{NS} (5.875)	0.094 ^{NS} (5.016)
—*Physical capital*					
Radio set	Γ_{11k}	**-42.651*** (6.407)**	**-29.36*** (3.979)**	**44.265*** (5.876)**	**43.286*** (4.700)**
TV set	Γ_{12k}	**-18.062*** (6.007)**	**-13.145*** (4.200)**	**14.149** (5.585)**	**13.515*** (4.965)**
Mobile phone	Γ_{13k}	**-14.117** (6.795)**	**-10.093** (5.159)**	**14.121** (6.288)**	**12.635** (5.959)**
Electricity	Γ_{14k}	-9.909 ^{NS} (7.264)	-7.604 ^{NS} (4.417)	4.089 ^{NS} (6.592)	2.595 ^{NS} (4.821)
Vehicle	Γ_{15k}	**-24.189* (12.937)**	**-20.523*** (7.137)**	**16.411 ^{NS} (10.480)**	**15.437** (6.257)**
Motorbike	Γ_{16k}	**-15.375** (6.979)**	**-14.328*** (4.561)**	**14.594** (6.024)**	**12.959*** (4.235)**
—*Financial capital*					
Credit	Γ_{17k}	-3.839 ^{NS} (15.151)	-1.682 ^{NS} (5.820)	7.009 ^{NS} (13.043)	7.674 ^{NS} (5.810)
Off-farm activity	Γ_{18k}	3.342 ^{NS} (6.996)	2.716 ^{NS} (4.145)	-5.791 ^{NS} (6.273)	-5.649 (4.261)
—*Social capital*					
Farmer association	Γ_{19k}	**-12.341** (5.757)**	**-8.412** (4.164)**	**8.009 ^{NS} (5.314)**	**8.804** (4.431)**
Extension	Γ_{20k}	8.836 ^{NS} (7.451)	5.966 ^{NS} (4.390)	-7.694 ^{NS} (6.769)	-6.235 ^{NS} (4.686)
Ogbomosho	Γ_{21k}	3.390 ^{NS} (9.333)	0.569 ^{NS} (5.428)	-3.999 ^{NS} (8.445)	-2.385 ^{NS} (5.890)
Oyo	Γ_{22k}	-7.637 ^{NS} (9.017)	-6.919 ^{NS} (5.478)	13.972* (8.179)	10.132* (5.705)

Table 4. Continued.

Variable	Parameter	Middlemen channel		Processor channel	
		Coefficient	Marginal effect	Coefficient	Marginal effect
Saki	Γ_{23k}	**-14.643***	**-10.789****	**7.205** NS	**6.746** NS
		(8.224)	**(5.492)**	**(7.554)**	**(5.783)**
—*Market conditions*					
Market information	Γ_{24k}	**-30.146*****	**-20.519*****	**26.354*****	**24.520*****
		(6.939)	**(4.615)**	**(6.561)**	**(5.703)**
Road (Tared road)	Γ_{25k}	**-13.168***	**-12.796****	**11.286***	**11.119****
		(6.687)	**(5.015)**	**(5.892)**	**(4.973)**
Price of cassava tubers (log)	Γ_{26k}	-4.119 NS	-4.312 NS	0.691 NS	0.094 NS
		(10.419)	(7.203)	(9.397)	(7.359)
Transport cost (log)	Γ_{27k}	2.367 NS	1.821 NS	**-5.302****	**-4.951****
		(2.851)	(1.980)	**(2.478)**	**(1.997)**
—*Diagnostic statistic*					
Pseudo log-likelihood	*PLL*			-2272.906	
Observation	*N*			400	
Sigma1	σ_1	42.891***			
		(1.884)			
Sigma2	σ_2			39.944***	
				(1.529)	
Rho12	ρ_{12}			-0.953***	
				(0.006)	
Likelihood ratio test of Rho12=0	ρ_{12}=0			557.311***	

***, **, *: p>0.01, p>0.05 and p>0.10 statistical significances, respectively. NS: not statistically significant. Log refers to natural logarithm. *Source:* Authors' estimations based on the survey data, 2016.

Physical capital variables

Five out of the six physical capital variables, mainly ownership of a radio set, a TV set, a mobile phone, a vehicle and a motorbike showed statistically significant effects on the farmers' participation in the cassava marketing channels (Table 4). Specifically, the coefficient and marginal effect of farmers' ownership of a radio set showed significant negative effects on the percentage of cassava output sold to middlemen at p>0.01 and p>0.01, respectively (Table 4). This result indicated that farmers' ownership of a radio set tended to decrease the percentage of their cassava output supplied to middlemen by 29.3%. On the contrary, the coefficient of farmers' ownership of a radio set exhibited a significant positive influence on the percentage of cassava output supplied to processors at p>0.01. The marginal effect was positively significant at p>0.01, implying that farmers who owned a radio set increased the percentage of cassava output sold to processors by 43.3%.

Table 4 further shows that ownership of a TV set was negatively correlated with the percentage of cassava output that cassava farmers decided to sell to middlemen, and it was statistically significant at p>0.01. The marginal effect was negative and significant at p>0.01, which indicated that farmers' ownership of a TV set influenced their decisions to reduce the percentage of cassava output sold to middlemen by 13.1%. Nevertheless, the coefficient of ownership of a TV set exerted a positive significant effect on the farmers' participation in the processor marketing channel at p>0.05. Similarly, the marginal effect exhibited a positive sign and it was statistically significant at p>0.01. This finding suggested that farmers' ownership of a TV set stimulated their decisions to increase the supply of cassava output to processors by 13.5%.

Also, the coefficient of ownership of a mobile phone was negative and statistically significant at p>0.05 for middlemen marketing channel. The result in Table 4 shows a significant negative marginal effect of ownership of a mobile phone in the middlemen model at p>0.05. This empirical result implied that farmers' ownership of a mobile phone tended to reduce the percentage of their cassava output sold to middlemen by 10.1%. For the processor marketing channel, the coefficient and marginal effect of farmers' ownership of a mobile phone exhibited positive signs, and they were statistically different from zero at p>0.05 (Table

4). The significant marginal effect (12.6) showed that farmers who owned a mobile phone had a higher tendency to increase the supply of their cassava output to processors by 12.6%. The coefficients and marginal effects of farmers' access to electricity exerted no significant effects on the proportion of cassava output sold to middlemen or processors at $p>0.10$ (Table 4).

The coefficient of farmers' ownership of a vehicle showed a negative significant effect on the proportion of cassava output sold to middlemen at $p>0.10$. The marginal effect of farmers' ownership was negative and statistically significant at $p>0.01$. This empirical finding implied that cassava farmers who owned a vehicle tended to reduce the proportion of cassava output sold to middlemen by 20.5%. Although the coefficient of farmers' ownership of a vehicle exhibited no statistical significance in the middlemen model, the marginal effect showed statistical significance at $p>0.05$. This significant marginal effect demonstrated that farmers who had a vehicle were likely to increase the percentage of cassava tubers sold to processors by 15.4%.

Moreover, the coefficient and marginal effect of farmers' ownership of a motorbike showed significant negative signs in the middlemen model and they were statistically significant at $p>0.05$ and $p>0.01$, respectively. This significant marginal effect (-14.3) suggested that farmers who had a motorbike tended to decrease the percentage of their cassava output sold to middlemen by 14.3%. On the contrary, both the coefficient and marginal effect of farmers' ownership of a motorbike were positive and statistically significant at $p>0.05$ and $p>0.01$, respectively, in the processor marketing channel model. The marginal effect of 13.0 implied that farmers' ownership of a motorbike increased their supply of cassava output to processors by 13.0%.

Financial capital variables

Furthermore, Table 4 shows that none of the financial capital variables, notably farmer access to credit and farmer participation in an off-farm activity included in the empirical models exhibited no statistically significant effects on farmer participation in the processor and middlemen marketing channels ($p>0.10$). This empirical evidence demonstrated that farmers' access to financial capital did not influence their decisions to participate in the middlemen or processor marketing channels.

Social capital variables

The empirical result showed that the coefficient and marginal effect of membership of farmer associations were negative in the middlemen model and statistically significant at $p>0.05$ (Table 4). The marginal effect was -8.4 which showed that farmers who were members of farmer associations had a tendency to decrease the percentage of their cassava output supplied to middlemen by 8.4%. The coefficient of membership of farmer associations exhibited no statistically significant influence on farmer participation in the processor marketing channel ($p>0.10$). However, the corresponding marginal effect (8.8) was positive and statistically significant ($p>0.05$). This result indicated that membership of farmer associations was likely to increase the percentage of cassava output sold to processors by 8.8%. The result further showed that farmer access to extension services did not influence the proportion of cassava output sold to middlemen and processors ($p>0.10$).

Two of the location variables, specifically Oyo and Saki agricultural development zones (ADZs) exhibited statistical significant effects on farmer participation in the processor and middlemen marketing channels, respectively (Table 4). The marginal effect of the Oyo location variable was 10.1 and this implied that farmers located in the Oyo ADZ were more likely to increase the quantity of their cassava output sold to processors by 10.1%. On the contrary, the marginal effect (-10.8) of Saki ADZ was negative which suggested that Saki farmers tended to reduce their supply of cassava tubers to middlemen by 10.8%.

Market conditions

Table 4 shows that three out of the four variables (namely, market information, road network, transportation costs) used as proxies for market conditions showed significant effects on farmers' participation in the cassava markets. The result indicated that the coefficient and marginal effect of farmers' access to market information exerted significant negative effects in the middlemen model ($p>0.01$). The significant marginal effect (-20.5) demonstrated that farmers' access to market information on either price or buyer reduced their volume of cassava output supplied to cassava middlemen by 20.5%. Conversely, in the case of processor marketing channel, the marginal effect of farmers' access to market information exhibited a positive sign and it was statistically significant ($p>0.01$). This result showed that farmers who had access to market information on price or buyer were likely to increase their supply of cassava output to processors by 24.5%.

The coefficient and marginal effect of the tarred road were negative and statistically significant at $p>0.10$ and $p>0.05$, respectively. The marginal effect of -12.8 implied that farmer access to good road networks linking their farming communities to marketing

centres tended to lower the proportion of cassava output sold to middlemen by 12.6% in contrast to the poor road networks. On the other hand, the coefficient and marginal effect of farmers' access to tarred road network were significant at $p>0.10$ and $p>0.05$, respectively, in the processor marketing channel model. The marginal effect (11.1) showed that good road networks connecting farmers' communities to market centres encouraged farmers to increase the quantity of cassava output sold to processors by 11.1%.

Interestingly, the coefficients and marginal effects of the price of cassava output per tonne exhibited no statistical significance in the middlemen or processor models at $p>0.10$ (Table 4). This unexpected finding showed that the price of cassava output did not influence farmers' decisions to intensify their participation in the middlemen and processor marketing channels.

Moreover, the coefficient and marginal effect of transportation costs were negative but showed no statistical significance ($p>0.10$) for middlemen. However, in the case of processor marketing channel, the coefficient and marginal effect were statistically significant at $p>0.05$. The significant marginal effect (-5.0) suggested that one-percentage-point increase in transportation costs tended to influence cassava farmers' decisions to reduce the proportion of their cassava output sold to processors by 5.0%.

Discussion

Cassava is an important cash crop for farmers in Nigeria and other cassava producing countries in Africa. Therefore, improving the farmers' access to direct markets is essential to enhance their farm productivity and incomes to promote rural development. This makes it necessary to investigate the effects of the determinants of cassava farmers' participation in the agricultural marketing channels, notably the cassava marketing channels. The study showed that farmers were actively involved in the cassava markets and they also sold a higher percentage of their cassava output. The main sources of markets for farmers in the Oyo State of Nigeria were processors and middlemen marketing channels. On average, farmers sold a higher proportion of their cassava output to processors. These processors were located in nearby peri-urban communities. Farmers incurred transportation costs to convey cassava tubers to these buyers. The transportation costs for participating in the processor marketing channel was higher than that of middlemen marketing channel. However, processors offered farmers a better price than middlemen. The price offered by processors could pay for the transportation costs and farmer could still generate an extra income on per tonne of cassava output sold (Table 2). Hence, it is plausible to infer that farmers' participation in the processor marketing channel can enhance their profit margin. On the one hand, if farmers are unable to bear the extra marketing risk of trading directly with processors, they can allow middlemen to perform the marketing function for them. In this case, farmers shift the marketing risk to middlemen but tend to receive relatively low profit margins.

The empirical results showed that human capital, physical capital, social capital and market conditions were the main determinants of the farmers' participation in the cassava marketing channels. On the other hand, natural and financial capitals did not influence the farmers' participation in the marketing channels.

Regarding human capital variables, farmer gender and household size influenced rural farmers' decision to trade with middlemen and processors. This result provided the evidence that male farmers increased the volume of their cassava output traded with middlemen. In the context of rural communities, males are known for agricultural production whereas females are more active in the marketing of the agricultural commodities including cassava output. Therefore, males may prefer to supply a larger proportion of their cassava commodity to middlemen at the farm gate instead of searching for processors in the nearby peri-urban communities. Our finding is consistent with Adejobi & Adeyemo (2012) who found that male farmers operated on a lower marketing channel than females in both raw cassava tuber and processed cassava product markets in Nigeria. Another observation made in the present study is that female farmers are more aware of marketing opportunities because they are more networked socially and they assume most marketing functions in the agricultural sector in West Africa (Martey *et al.*, 2012). However, other studies suggested that farmer gender had no significant influence on market participation (Osmani & Hossain, 2015; Sigei *et al.*, 2015). Farmers with large households had a higher preference to trade with middlemen. Hence, they increased the supply of cassava commodity to middlemen. Large households in rural areas are mostly constrained with financial burdens, so they tend to avoid transaction costs and other marketing risks associated with the participation in the direct marketing channels. These farmers with large households allocate a higher proportion of their cassava commodity to middlemen at the farm gate to generate incomes to cater for their immediate household financial needs.

Besides human capitals, ownership of physical capitals such as a mobile phone, a radio set, a TV set, a vehicle and a motorbike affected farmers' decisions to intensify the supply of their raw cassava commodity to

either processors or middlemen. Mobile phones have become an important source of information for rural farmers. Farmers use mobile phones to communicate with processors who are located in nearby peri-urban communities and negotiate with buyers the price and the quantity to be supplied. Through mobile phones, farmers can take advantage of price differences across markets, times, and different buyers (Tadesse & Bahiigwa, 2015). However, the quality of mobile network services remains a great challenge in most rural areas. This can restrict the effective use of mobile to retrieve information from distance markets. Our finding concurs with Aker & Fafchamps (2013) that suggested mobile phone coverage had improved market efficiency and reduced consumer prices for certain food commodities in some Sub-Saharan African countries (Aker & Fafchamps, 2013). Furthermore, the invention of mobile money has made it easier for processors to pay farmers at distance places via this mobile money transfer innovation. These benefits of mobile phone enable farmers to participate in the direct marketing channels.

Radio and TV sets are another important sources of information for farmers. Some agricultural programmes including the marketing of food commodities are broadcast on radio and TV programmes. Such programmes are mostly done by the International Institute of Tropical Agriculture (IITA) located in Ibadan, Nigeria and other stakeholders in the cassava industry. Therefore, farmers who had a radio set and a TV set could easily get pieces of information on the dynamics of the agricultural markets which strengthened their bargaining power with processors. Moreover, the result showed that ownership of transport assets such as vehicles and motorbikes enabled farmers to overcome transportation challenges. These transport assets helped farmers to trade directly with processors without allowing middlemen to assume the marketing function for them.

The social capital variable, membership of farmer associations, tended to increase the volume of trade of cassava output with processors but it decreased the percentage of cassava output sold to middlemen. Members of farmer associations can undertake group marketing which assists them to overcome transaction costs and trade directly with processors. Furthermore, the cassava farmer association in the Oyo State of Nigeria tends to build a strong relationship with some processor associations to supply them with cassava tubers at negotiated prices. A similar result was obtained by Osmani & Hossain (2015) that revealed membership of association increased the quantity of food commodities supplied to the market. Also, members of farmer associations share market information and broaden social network within the groups, thereby enabling them to identify processors in their nearby peri-urban communities (Jari & Fraser, 2009). Location differences affected rural farmers' marketing decisions on the proportion of commodity sold to the different buyers. It is acknowledged that some farmers are located in areas which are close to processing sites whereas others are suited at distant places. This implies that farmers located near cassava processing sites can increase their volumes of trade with processors whereas those in distant places may rely on middlemen to perform the marketing function for them. In the context of this study, farmers located in Oyo and Saki were closer to processing sites so they sold a large quantity of cassava output to processors contrast those in Ibadan.

Access to market information, access to good road networks and transportation costs were the market conditions that influenced farmers' engagement in the cassava markets. This result suggested that access to market information encouraged farmers to intensify their participation in the direct market, notably the processor marketing channel. Access to market information enables farmers to overcome information asymmetry, which middlemen use to overexploit them. Access to market information also increases farmers' bargaining power and this empowers them to negotiate with the buyers for a higher price. Consistent with this result, Martey *et al.* (2012) found that access to market information assisted farmers to identify potential buyers; hence, they intensified their participation in markets. Alene *et al.* (2008) observed that a better access to market information stimulated a higher participation in a direct market among rural farmers.

Another market condition that enabled farmers to intensify their supply of cassava tubers directly to processors was better road networks. Most farmers were allocated in rural areas where there were poor road networks, and this served as a barrier for most farmers to engage in trade with processors who were in peri-urban communities. Poor road network tended to increase the costs of transportation because transport owners charged higher for dilapidated road networks. The transaction cost theory suggests that farmers try as much as possible to avoid markets associated with high transaction costs (Barrett, 2008). This, therefore, implies that farmers located in areas where the road networks are poor tend to sell larger quantities of their cassava outputs to middlemen despite being offered with a lower price. This enables farmers to transfer the marketing risk to the middlemen who are faced with fewer budget constraints. Our finding is consistent with Umberger *et al.* (2015) who observed that long distance coupled with the poor nature of road increased transportation costs thereby raising the marketing risks.

These observations also agree with the argument raised by de Janvry *et al.* (1991) that transaction costs were the main barriers to smallholder farmers' participation in the direct market.

It is expected in this study that the price differential exerts a significant effect on the proportion of cassava output supplied to processors or middlemen. Unexpectedly, the study showed that the price differential did not influence the supply of cassava tubers to processors and middlemen. The reason was that there was a small variation in the prices offered by processors and middlemen located in different communities in the Oyo State of Nigeria. This explanation is supported by the low standard deviation of the prices paid offered by processors and middlemen (Table 2). However, the mean difference of the price offered by processors and middlemen was statistically different from zero. This gives the impression that the price paid by processors was higher than that of middlemen. Our finding collaborates with the argument raised by Barrett (2008) that the commodity price is not the only factor that affects farmers' participation in the market. In absence of better market conditions such as better rural road networks, improved access to market information, and reduced transport cost, there would be poor coordination of marketing functions by rural farmers whose marketing decisions tend to be influenced by commodity price.

The study concludes that farmers' participation in the direct marketing channel can improve their livelihoods by raising their profit margins. To increase and sustain farmers' active participation in the direct marketing channel, this study suggests the following policy recommendations. First improving market conditions in rural cassava farming communities is necessary to increase farmers' participation in the direct marketing channel. Specifically, it is important to improve rural-urban road networks to minimise transportation costs associated with the farmers' participation in the direct marketing channel. In addition, farmer access to communication assets such as mobile phones, radio sets and TV sets as well as transport assets, mainly vehicles and motorbikes needs to be encouraged. Access to these communication and transport assets, respectively, are likely to enhance farmers' access to market information and help them overcome the difficulty in the transportation of cassava output to potential buyers. Also, increasing membership of farmer associations and supporting these associations should be a policy priority. It is expected that the effective implementation of these policy recommendations of the present study is likely to enhance the farmers' participation in direct marketing channels.

This study only focused on the effects of the five capital variables and market conditions on farmers' participation in the markets. It is therefore recommended that future research should incorporate political and cultural capital variables in the analysis of farmers' marketing decisions. It is acknowledged that the study was limited to one of the States in Nigeria; hence, the extrapolation of the findings should be done with caution. However, the study's findings study can be beneficial to promoting farmer participation in the direct markets in other states of Nigeria and possibly other cassava producing countries in Africa.

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