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Marketing efficiency of cassava products in Delta State, Nigeria: A stochastic profit frontier approach

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ABSTRACT

The present study estimates the level of marketing margin and marketing efficiency of cassava products (i.e., root tuber, gari, fufu, tapioca, starch, and flour) of 105 marketers from three regions of Delta State, Nigeria using a stochastic profit frontier approach. Results reveal that a rise in purchase price of cassava products as well as unit marketing cost significantly reduce marketing margin. A rise in sale price of cassava products increase marketing margin as expected. Marketing experience significantly improves marketing margin as expected. The mean level of marketing efficiency is very low estimated at 55% implying that marketing margin can be substantially increased by eliminating inefficiency arising out of inappropriate allocation of resources, response to prices and scale of operation. Marketing efficiency is significantly higher for marketers who are farmers and the gender of marketer has no impact on efficiency. However, marketers in the Northern Delta region are relatively efficient but inefficient in Central Delta relative to Southern Delta. Policy implications include investment in market infrastructure to reduce fluctuation in prices and marketing costs and training on marketing and market functions for marketers to develop marketing experience.

KEYWORDS: marketing margin; marketing efficiency; stochastic profit frontier; cassava and cassava products; Delta State, Nigeria

1. Introduction

Cassava (*Manihot esculenta)* is an important staple crop for 550 million people in developing countries (Nweke, 2004) and it is the sixth major staple in the world after rice, wheat, maize, potato and sweet potato (Nassar and Ortiz, 2007). In Africa, cassava is gradually changing its status from a famine-reserve, rural food staple and non-tradable crop to a cash crop destined for urban consumption, livestock feed, export and industrial raw materials (Nweke 2004). The world leading producers are Nigeria, Ghana, Brazil, Democratic Republic of Congo, Indonesia, Tanzania and Thailand with African countries producing more than 50% of the total world production (FAO, 1995; 2011; Nassar and Ortiz, 2006). Nigeria ranked first in the world in cassava production in 2009 where 3.1 million ha was planted producing 37 million tonnes with an average yield level of 11.8 t/ha (FAOSTATS, 2011).

Cassava has a number of uses ranging from consumption to industrial use through processing of the cassava root tuber (CRT), e.g., into gari, starch, akpu, tapioca, and dried chips among others. Gari are fine white or yellow granules processed from harvested CRT which is peeled, then grated into pulp, then fermented, dried and roasted into fine granules. Akpu is a pasty product of cassava, which is sieved first and then fermented, boiled or cooked and pounded to pasty moulded products. Tapioca is produced from peeled CRT, sliced into chips, then soaked, fermented, dried or roasted into dried flakes. Further processing involves grinding and milling into flour.

Chukwuji *et al.*, (2007) and Farinde *et al.*, (2007) noted that the problem of spoilage and bulkiness of cassava root tuber could be overcome through processing. Dada *et al.* (2007) emphasized that value chain improvement is imperative to sustain cassava sector as it will help to strengthen the links between supply and demand. Furthermore, Kaine (2011), Chukwuji *et al.* (2007) and Osomtimehin *et al.* (2006) concluded that processing of cassava root tuber increases its shelf-life in storage and that adding value leads to an increase in marketing margin of the processors.

Several studies (e.g., Chukwuji *et al.* 2007; Liverpool-Tasie, 2011 among others) suggest that any attempt to increase productivity growth and efficiency in crop production and processing without markets for the products is unlikely to result in success. Sugino and Magrowani (2007) indicated that increase in the demand for processed crop products has a tendency to encourage processing by the processors. Marketing of cassava in Nigeria is generally limited by constraints such as lack

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of information and infrastructure, such as good road networks, storage facilities, capital and credit provision (Asogwa *et al.* 2011; Erhabor and Omokaro, 2011; Okoh and Dominic, 2004; Okoh, 1999). It is imperative that expansion of marketing will greatly enhance productivity, income and employment opportunities for the cassava sector.

Given this backdrop, the main objectives of this study are to: (a) examine the level of marketing margin or profitability in selling cassava and its products; (b) estimate the level of marketing efficiency of individual marketers (i.e., retailers or wholesalers) of cassava and its products; and (c) identify the socio-economic determinants of marketing efficiency of cassava and its products.

In order to analyse marketing efficiency and its determinants, we have applied a stochastic profit frontier approach which is not commonly seen in the existing literature[3]. Conventionally marketing efficiency is computed simply as the ratio of total revenue to total marketing costs or a variant of this (e.g., Odiomenem and Otanwa, 2011; Umar *et al.*, 2011; Afolabi, 2009; Mafimisebi, 2007). Also, standard linear regression methods are commonly used to identify socio-economic determinants of marketing/gross margin (e.g., Odiomenem and Otanwa, 2011; Umar *et al.*, 2011; Afolabi, 2009; Mafimisebi, 2007; Olukosi and Isitor, 1990; Obasi and Mejeha, 2008; and Akinupelu and Adenegan, 2011) which invariably assumes perfect efficiency in marketing. Given widespread evidence of inefficiency in agricultural production in developing economies (Bravo-Ureta *et al.*, 2007), it is unlikely that marketing of agricultural products will be perfectly efficient, as we are aware that the marketing sector is riddled with several constraints (Asogwa *et al.* 2011; Erhabor and Omokaro, 2011; Okoh and Dominic, 2004; Okoh, 1999).

The paper is structured as follows. Section 2 presents the analytical framework and a description of the study areas and the data. Section 3 presents the results. Section 4 provides discussion and draws policy implications.

2. Methodology

Measuring marketing efficiency using profit frontier function

The main assumption of using a profit function approach to analyze marketing efficiency is that the marketers engage in marketing activities to maximize marketing margin or profit defined as the difference between total revenue obtained from selling the products minus total variable costs incurred in the marketing process. In this framework marketing inefficiency can arise from two main components – allocative and scale inefficiency. A marketer is said to be allocatively inefficient if it is not using marketing inputs in optimal proportions (e.g., use of labour for loading, transportation, storage, marketing space, utilities, etc.) given their observed prices. A marketer can also be scale inefficient if the marketer does not sell the quantity of products at a selling price which is equal to the marginal cost of marketing. These two sources of inefficiencies can be combined and analyzed through one system which is the profit function framework (e.g., Ali and Flinn, 1989; Kumbhakar *et al.*, 1989; Ali *et al.*, 1994; Wang, *et al.*, 1996 and Rahman, 2003 used this framework to analyze efficiency in agricultural production).

A profit function approach is appropriate to estimate firm specific efficiency directly when firms face different prices and have different factor endowments (e.g., Kumbhakar *et al.*, 1989; Ali and Flinn, 1989; Ali *et al.*, 1994; Wang *et al.*, 1996; Kumbhakar, 2001; Rahman, 2003), which is more appropriate in the context of marketing. Broadly, the profit function approach combines the concepts of technical, allocative and scale inefficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer (Ali *et al.*, 1994). Therefore, for our purpose, we define marketing efficiency as the ability of a marketer to achieve highest possible marketing margin or profit given purchase and selling prices of the products and the levels of fixed factors of the firm, and in this context marketing inefficiency is defined as loss of profit/margin from not operating on the frontier.

Furthermore, we adopt Battese and Coelli (1995) model to identify the determinants of marketing inefficiency where these can be expressed as a linear function of the explanatory variables reflecting firm specific characteristics and can be estimated along with firm specific marketing/profit efficiency scores in a single stage estimation procedure.

The stochastic profit frontier model

The stochastic profit function is defined as

$$\pi_i = f(P_i, Z_i).\ exp\ (\xi_i) \quad (1)$$

where π_i is normalized profit of the ith firm defined as gross revenue less variable cost, divided by firm-specific output price (P_y); P_i is the vector of variable input prices faced by the ith firm divided by output price (P_y); Z_i is the vector of fixed factor of the ith firm; ξ_i is an error term; and i=1, ….., n, is the number of firms in the sample.

The error term ξ_i is assumed to behave in a manner consistent with the frontier concept (Ali and Flinn, 1989), i.e.,

$$\xi_i = v_i - u_i \quad (1a)$$

where v_is are assumed to be independently and identically distributed $N(0,\sigma^2_v)$ two sided random errors, independent of the u_is; and the u_is are non-negative random variables, associated with inefficiency in production, which are assumed to be independently distributed as truncations at zero of the normal distribution with mean, $\mu_i=\delta_0+\sum_d \delta_d W_{di}$ and variance σ_u^2 ($|N(\mu_i,\sigma^2_u|$), where W_{di} is the dth explanatory variable associated with inefficiencies on firm i and δ_0 and δ_d are the unknown parameters.

The marketing/profit efficiency of firm i in the context of the stochastic frontier profit function is defined as

$$EFF_i = E[\exp(-u_i)|\xi_i] = E[\exp(-\delta_0 - \sum_{d=1}^{D} \delta_d W_{di})|\xi_i] \quad (2)$$

[3] The approach is commonly used in analysing agricultural production efficiency (e.g., Ali and Flinn, 1989; Kumbhakar et al., 1989; Wang, et al., 1996 and Rahman, 2003)

where E is the expectation operator. This is achieved by obtaining the expressions for the conditional expectation u_i upon the observed value of ξ_i. The method of maximum likelihood is used to estimate the unknown parameters, with the stochastic frontier and the inefficiency effects functions estimated simultaneously. The likelihood function is expressed in term of the variance parameters, $\sigma^2=\sigma_v^2+\sigma_u^2$ and $\gamma=\sigma_u^2/\sigma^2$ (Battese and Coelli, 1995).

Empirical Model

The general form of the translog profit frontier, dropping the ith subscript for the firm, is defined as:

$$\ln \pi' = \alpha_0 + \sum_{j=1}^{2} \alpha_j \ln P'_j + \frac{1}{2}\sum_{j=1}^{2}\sum_{k=1}^{2} \tau_{jk} \ln P'_j \ln P'_k + \sum_{j=1}^{2}\sum_{l=1}^{2} \phi_{jl} \ln P'_j \ln Z_l + \sum_{l=1}^{2} \beta_l \ln Z_l + \frac{1}{2}\sum_{l=1}^{2}\sum_{t=1}^{2} \varphi_{lt} \ln Z_l \ln Z_t + v - u \quad (3a)$$

and

$$u = \delta_0 + \sum_{d=1}^{7} \delta_d W_d + \omega \quad (3b)$$

Where:

π'= restricted marketing margin/profit (total revenue less total cost of variable marketing inputs) normalized by price of output (P_y – i.e., weighted average sale price of cassava and cassava products)

P'_j= price of the jth input (P_j) normalized by the output price (P_y)

j = 1, weighted average purchase price of cassava and cassava products

= 2, weighted average marketing cost per unit of product

Z_l = quantity of fixed input

l = 1, education of the marketer (completed years of schooling)

= 2, marketing experience (years of cassava marketing experience)

v = two sided random error

u = one sided half-normal error

ln = natural logarithm

W_d= variables representing socio-economic characteristics of the firm to explain inefficiency

d = 1, age (years)

= 2, main occupation (dummy variable, farming = 1, 0 otherwise)

= 3, gender (dummy variable, male = 1, 0 otherwise)

= 4, credit received (dummy variable, received credit = 1, 0 otherwise)

= 5, subsistence pressure (number of persons per marketer household)

= 6, firms located in Central Delta region (dummy variable, Central = 1, 0 otherwise)

= 7, firms located in South Delta region (dummy variable, South = 1, 0 otherwise)

ω = truncated random variable

$\alpha_0, \alpha_j, \tau_{jk}, \beta_l, \phi_{jl}, \varphi_{lt}, \delta_0$, and δ_d are the parameters to be estimated.

Study area, sampling procedure and the data

Data used for the study were drawn from three regions of Delta state, Nigeria which is situated at the South-southern (Niger Delta) part of the country. These are, North, Central and South Delta regions which have different agro-ecological characteristics. The major foods grown in Delta state are cassava (leading producer), yam, plantain, maize, and vegetables (MANR, 2006). Delta state was selected as the case study area for this research because it has the ideal climatic and soil conditions for cultivation of cassava and is a very important staple crop of the state.

Sampling of cassava marketers (i.e., wholesalers/ retailers) was based on the cell structure developed by the Delta State Agricultural Developmental Programme[4]. First, nine local government areas (LGAs) of the total 25 LGAs in the state (3 LGAs from each region) were selected randomly. Next, 35 marketers of cassava and cassava products from each region (i.e., 10–12 marketers from each of the nine LGAs) were selected randomly. This provided a sample size of total 105 marketers (39 marketers from Delta Central, 40 from Delta South and 26 from Delta North regions) spread across 20 markets in these three regions for primary data collection. The criteria used for selecting markets are: (a) markets must trade in cassava and/or cassava products; and (b) markets must operate at least once a week. The average frequency of market day was estimated at 4 days (i.e., every 5th day is a market day with a range of 1–7 days).

For primary data collection, a structured questionnaire was administered containing both open and closed type questions. A team of two research assistants (who are agricultural officers from the regional office of the Ministry of Agriculture in Delta State) were trained by the co-author and all three members were involved in collecting primary data using face to face interview method with the marketers in the market place. Interviews took place mainly in English language although the co-author is a native of Delta State, Nigeria. Detailed information on the quantities of cassava and its products that are purchased and marketed, purchase and sale prices of each product, cost of marketing, and constraints in marketing were collected from each marketer. Also, demographic and socio-economic information from each marketer included age of the marketer, years of marketing experience, main occupation, family size, education (completed years of schooling), credit, and gender of the marketer. The survey was conducted during September to December, 2008.

3. Results

Marketing margin of cassava and its products

Table 1 presents information on revenue, cost and marketing margin per kg of cassava and cassava products marketed for two rounds of supplies per marketer. A total of six products are identified: cassava

[4] The paper is developed from the data of co-author's doctoral research project which included an investigation of farm-level productivity and efficiency in production and processing of 315 cassava farmers (105 farmers from each region) and marketing activities/issues related to cassava and its products from 105 marketers (wholesaler/ retailers) located in the same three regions where farm survey was conducted.

Table 1: Marketing margin of cassava and cassava products (per kg)

Variables	Cassava root tuber	Gari	Cassava starch	Fufu	Tapioca	Cassava flour
Prices (per kg)						
Sale price of the product	28.41	79.84	110.05	101.37	252.93	206.43
Purchase price of the product by the marketer	16.22	57.22	78.51	71.52	121.08	134.63
Ratio of price difference (Sale price/Purchase price)	1.75	1.40	1.40	1.42	2.09	1.53
Revenue (per kg)						
Total revenue from sale (TR)	28.41	79.84	110.05	101.38	252.93	206.43
Cost (per kg)						
Product purchase cost (PC)	16.22	57.22	78.51	71.52	121.08	134.63
Marketing cost (per kg)						
Fees	0.43	0.42	0.42	0.43	0.42	0.42
Cost of utilities	0.52	0.52	0.53	0.52	0.52	0.53
Loading cost	2.15	2.12	2.19	2.21	2.05	2.04
Transportation cost	3.42	3.43	3.40	3.48	3.46	3.62
Rent	0.47	0.46	0.47	0.48	0.47	0.46
Total marketing cost (MC)	6.99	6.97	7.00	7.12	6.93	7.07
Total cost TC = PC+MC	23.22	64.18	85.51	78.64	128.01	141.71
Marketing Margin (Profit) per kg (π= TR– TC)	5.19	15.66	24.54	22.74	124.93	64.72
Percent of marketers selling the product (%)	87	89	58	66	71	47

Source: Computed from Field Survey, 2008.

root tuber, gari, starch, fufu, tapioca and cassava flour[5]. Marketers are involved in marketing multiple products with a mean of 4.17 products. The marketing margin varies significantly across product types ($p<0.000$ from ANOVA) and is highest for tapioca followed by cassava flour and lowest for cassava root tuber. The main contributor to marketing margin is the difference between the purchase price and sale price of the products. Although such price difference is highest for tapioca (209%), the second highest difference (175%) is for cassava root tuber whereas its marketing margin is lowest. Gari is the most popular processed cassava which provides marketing margin three times that of cassava root tuber.

Processing cassava into various products is largely labour intensive. For example, average processing time of 100 kg of cassava root tuber into gari is 18 hours, cassava flour is 16 hours and tapioca is 28 hours, respectively when traditional method is used (Okorji *et al.*, 2003). Also, recovery rate of the processed product from fresh root tuber varies depending on a number of factors including moisture content, method of processing and use of equipment. For example, the approximate conversion rate of fresh root tuber into gari is 15–20% (Hahn, 1992). Therefore, the mark-up of the purchase price of the processed product seen in Table 1 somewhat reflects these underlying costs incurred in processing cassava into value added products by the farmers/processors.

The marketing cost of cassava and/its products is relatively low and is similar across products ranging from Naira (N) 6.93–7.12 per kg (Tables 1)[6]. A number of elements make up the total marketing cost. These are: (a) fees (includes commission, and fees for agent, association and council), (b) cost of utilities (includes costs of storage, security, electricity, and water supply), (c) loading cost (mainly labour cost for loading and unloading of products), (d) transportation cost (from the point of purchase to the market; the average distance was estimated at 2.93 ± 3.13 km with a range of 1–15 km), and (e) rent for market stall/space. Loading and transportation account for 79% of the total marketing cost. In the cassava marketing process, there are intermediaries (known as commission/assembling agents) who buy cassava root tubers and their products from farmers and processors. They may also be farmers and/or processors themselves buying small quantities from other farmers and processors as they come into the market. After procuring products, they reassemble and resell to the wholesalers, processors, industries, retailers and final consumers within the market. These intermediaries charge commissions at a fixed rate. Each market is managed by a marketing association who also charges fees. Also, each market is regulated by local council who also charges fees. Loading and unloading of cassava and its products is largely done by hired labourer paid at market wage rate. The main mode of transporting cassava and its products are by hired pick-up van noted by 92.7% of marketers.

Quantity of products marketed and socio-economic characteristics of the marketers

Table 2 presents the distribution and summary statistics of the variables used in the profit frontier model and is also classified by regions. It is clear from Table 2 that the actual amount of products marketed varies by per marketer as well as by region. Overall, the dominant product marketed is gari followed by cassava root tuber and starch. This is because gari is an important staple in this state and hence the market for gari trade is relatively large as compared to other high value processed products. At the individual marketer level, the actual marketing margin from trading in cassava and its products is substantially high but lowest in Delta Central. High marketing margin was made possible by

[5] Other cassava products such as chips and biscuits are not found to be traded by these marketers.

[6] In late September 2014, 100 Naira was approximately equivalent to £0.38, €0.47, and $0.61 (www.xe.com)

Table 2: Summary statistics of the variables used in the model (per marketer)

Variables	Definition and measurement	Delta Central	Delta South	Delta North	Overall	
		Mean	Mean	Mean	Mean	Standard deviation
Products, marketing margin and prices						
Cassava root tuber	Quantity sold per marketer (kg)	2235.87	2710.70	4617.30	3006.45	2326.65
Gari	Quantity sold per marketer (kg)	2189.70	4292.55	3960.92	3429.41	2575.93
Fufu	Quantity sold per marketer (kg)	245.02	421.35	1439.35	606.95	793.07
Cassava starch	Quantity sold per marketer (kg)	1871.28	578.87	626.92	1070.81	1907.36
Tapioca	Quantity sold per marketer (kg)	730.52	606.75	412.69	604.66	687.28
Cassava flour	Quantity sold per marketer (kg)	67.67	577.25	925.77	473.90	761.14
Marketing margin	Profit per marketer (Naira)	172608.90	235540.25	261159.00	218505.90	162998.20
Sale price	Weighted average of six product sale prices (Naira per kg)	84.49	87.52	82.29	85.09	28.34
Purchase price	Weighted average of six product purchase prices (Naira per kg)	52.45	52.79	51.46	52.58	15.55
Marketing price	Weighted average of unit marketing cost of six products (Naira per kg)	6.83	6.86	7.30	6.95	1.22
Socio-economic factors						
Education	Completed years of schooling (Years)	6.54	6.42	5.04	6.12	4.22
Marketing experience	Years of marketing cassava and cassava products (Years)	11.41	15.88	12.31	13.33	8.56
Age	Age of the marketer (years)	37.69	44.45	45.19	42.12	12.85
Main occupation	Dummy (1= if farmer, 0= otherwise)	0.56	0.45	0.58	0.52	--
Credit facility	Dummy (1= if received credit, 0= otherwise)	0.28	0.55	0.42	0.42	--
Gender	Dummy (1= if male, 0= otherwise)	0.38	0.30	0.50	0.38	--
Subsistence pressure	Number of persons per household	6.18	5.40	5.38	5.83	2.25
Central Delta state	Dummy (1= if Central Delta, 0= otherwise)	1.00	--	--	0.37	--
South Delta state	Dummy (1= if South Delta, 0= otherwise)	--	1.00	--	0.38	--
North Delta state	Dummy (1= if North Delta, 0= otherwise)	--	--	1.00	0.25	--
Number of observations		39	40	26	105	

large differences in the purchase and sale prices of individual products (Table 1). Such large difference still existed between the weighted average purchase price of six products (computed at N 52.58 per kg overall) and the weighted average sale price of six products (computed at N 85.09 per kg overall). The weighted average marketing cost per unit of product sold is only N 6.95 per kg and is slightly higher in Delta North at N 7.30 per kg.

The lower panel of Table 2 provides the summary statistics of the socio-economic characteristics of the marketers which also vary by regions to some extent. The average level of education is just above the primary level of 6.12 years, average age (or overall experience) is 42.1 years, 52% of the marketers are actually farmers, only 38% are male indicating that cassava marketing is largely a female affair, subsistence pressure (i.e., family size) is 5.8 persons per household, and 42% of the marketers had some access to credit which establishes the case of a lack of financial support for an apparently costly business. The access to credit is lowest for marketers in Delta Central where only 25% received any credit.

Marketing efficiency of cassava and its products

One main limitation and/or criticism in applying a profit function model in a cross-section of data is the lack of variation in input and output prices. The geographical dispersion of the sampled marketers and imperfections in the markets in Nigeria ensure adequate variability in prices at any given point in time. However, a valid test is required to confirm this intuition. In our sample, both the purchase prices and the sale prices of cassava and cassava products varied widely across regions. Formal F-tests for differences in the purchase prices and sale prices of cassava and its products among the three regions rejected the null-hypothesis of 'no-difference' for most of the cases (except purchase prices of gari and fufu), thereby confirming that significant price variations exist in our sample, and hence, the application of the profit function model is justified (Table 3). In the model, the weighted average sale price per kg and purchase price per kg of six products was used (i.e., total value of sales divided by total quantity of all six products sold/purchased) which are also significantly different across regions (Table 3). These weighted average sale and purchase prices actually reflect true prices received and paid by the marketers. This is because not all marketers are involved in selling all six products. The weighted average price of marketing per kg (i.e., unit marketing cost), however, is not significantly different across regions.

Table 3: Test of hypothesis

Hypothesis	Null-hypothesis	Test statistic	Critical value	Decision
Prices do not vary across regions				
Purchase price of cassava	H_0: $P_{j11}=P_{j12}=P_{j13}=0$	F-statistic	11.20***	Significant variation in prices across regions
Purchase price of gari	H_0: $P_{j21}=P_{j22}=P_{j23}=0$	F-statistic	0.86	No significant variation in prices across regions
Purchase price of starch	H_0: $P_{j31}=P_{j32}=P_{j33}=0$	F-statistic	18.06***	Significant variation in prices across regions
Purchase price of fufu	H_0: $P_{j41}=P_{j42}=P_{j43}=0$	F-statistic	0.20	No significant variation in prices across regions
Purchase price of tapioca	H_0: $P_{j51}=P_{j52}=P_{j53}=0$	F-statistic	46.62***	Significant variation in prices across regions
Purchase price of cassava flour	H_0: $P_{j61}=P_{j62}=P_{j63}=0$	F-statistic	11.43***	Significant variation in prices across regions
Weighted average purchase price of all six crops	H_0: $P_{j1}=P_{j2}=P_{j3}=0$	F-statistic	2.71*	Significant variation in prices across regions
Sale price of cassava	H_0: $P_{y11}=P_{y12}=P_{y13}=0$	F-statistic	6.94***	Significant variation in prices across regions
Sale price of gari	H_0: $P_{y21}=P_{y22}=P_{y23}=0$	F-statistic	2.68*	Significant variation in prices across regions
Sale price of starch	H_0: $P_{y31}=P_{y32}=P_{y33}=0$	F-statistic	76.50***	Significant variation in prices across regions
Sale price of fufu	H_0: $P_{y41}=P_{y42}=P_{y43}=0$	F-statistic	26.03***	Significant variation in prices across regions
Sale price of tapioca	H_0: $P_{y51}=P_{y52}=P_{y53}=0$	F-statistic	39.45***	Significant variation in prices across regions
Sale price of cassava flour	H_0: $P_{y61}=P_{y62}=P_{y63}=0$	F-statistic	12.12***	Significant variation in prices across regions
Weighted average sale price of all six crops	H_0: $P_{y1}=P_{y2}=P_{y3}=0$	F-statistic	2.80*	Significant variation in prices across regions
Weighted average unit marketing cost of all six products	H_0: $P_{m1}=P_{m2}=P_{m3}=0$	F-statistic	1.39	No significant variation in prices across regions
Functional form test (Translog vs. Cobb-Douglas)	H_0: $\tau_{jk}=\phi_{kl}=\varphi_{lt}=0$ for all *j, k, l,* and *t.*	LR: $\chi^2(_{v,\ 0.95})$ 18.31	121.97***	Translog model is appropriate
Frontier vs. OLS (i.e., no inefficiency component)	H_0: M3T=0	z-statistic	50.29***	Frontier is appropriate, not OLS
Presence of inefficiency	H_0: $\gamma=0$	LR: $\chi^2(_{v,\ 0.95})$ 3.84	175.13***	Significant level of inefficiencies exist
Effect of socio-economic factors on marketing inefficiency	H_0: $\delta_1=\delta_2=\ldots.=\delta_7=0$	LR: $\chi^2(_{v,\ 0.95})$ 14.07	26.65***	Inefficiencies are jointly explained by these variables

Note: *** significant at 1 percent level ($p<0.01$).
**significant at 5 percent level ($p<0.05$).
*significant at 10 percent level ($p<0.10$).

Table 4 presents the maximum likelihood estimation of the stochastic profit frontier jointly with inefficiency effects function. Prior to discussing the results, we report the series of hypothesis tests conducted to select the functional form and to decide whether the stochastic profit frontier model is an appropriate choice rather than an average profit function. We also test for the validity of the variables used to explain marketing inefficiency. The results are reported at the lower panel of Table 3.

The first test was conducted to determine the appropriate functional form, i.e., the choice between Cobb-Douglas vs. translog functional form (H_0: $\tau_{jk}=\phi_{kl}=\varphi_{lt}=0$ for all *j, k, l,* and *n*). Generalised Likelihood Ratio (LR) tests confirmed that the choice of translog profit function is a better representation of the true marketing structure. Once the functional form is chosen, next we checked the sign of the third moment and the skewness of the OLS (Ordinary Least Squares) residuals of the data in order to justify use of the stochastic frontier framework (and hence the Maximum Likelihood Estimation procedure). The computed value of Coelli's (1996) standard normal skewness statistic (M3T) based on the third moment of the OLS residuals is presented in Table 3 which is tested against H_0: M3T=0. The null hypothesis of 'no inefficiency component' is strongly rejected and, therefore, use of the stochastic frontier framework is justified. The coefficient of γ reported at the bottom of Table 4 also strongly suggests presence of marketing inefficiency. The null hypothesis of 'no efficiency effects' (i.e., H_0: $\delta_1=\delta_2=\ldots=\delta_7=0$) is rejected at the 1% level of significance, implying that all these variables jointly have an influence on the marketing efficiency scores of individual marketers. Thus, a significant part of the variability in margin/profit among marketers is explained by the existing differences in the levels of allocative and scale inefficiency.

A total of 64% of the coefficients on the variables are significantly different from zero, implying satisfactory fit which was also supported by Wald Chi-square test

Table 4: Maximum likelihood estimates of the profit frontier function

Variables	Parameters	Coefficients	t-ratio
Profit function			
Constant	α_0	8.6018***	170.66
ln Cassava purchase price ($\ln P'_W$)	α_W	−1.6521***	−6.90
ln Marketing cost per unit ($\ln P'_M$)	α_M	−0.3913***	−72.87
½ (ln Cassava purchase price)^2 $(\ln P'_W)^2$	τ_{WW}	−4.6789***	−5.26
½ (ln Marketing cost per unit)^2 $(\ln P'_M)^2$	τ_{MM}	−2.2187***	−35.78
ln Cassava purchase price * ln Marketing cost per unit ($\ln P'_W$ * $\ln P'_M$)	τ_{WM}	−0.2430	−0.18
ln Cassava purchase price * ln Education ($\ln P'_W$ * $\ln Z_E$)	ϕ_{WE}	0.8523**	2.26
ln Cassava purchase price * ln Marketing experience ($\ln P'_W$ * $\ln Z_X$)	ϕ_{WX}	1.0590***	63.12
ln Marketing cost per unit * ln Education ($\ln P'_M$ * $\ln Z_E$)	ϕ_{ME}	−0.0178	−0.48
ln Marketing cost per unit * ln Marketing experience ($\ln P'_M$ * $\ln Z_X$)	ϕ_{MX}	0.0903	0.87
ln Education ($\ln Z_E$)	β_E	0.0050	0.17
ln Marketing experience ($\ln Z_X$)	β_X	0.0154**	1.96
½ (ln Education)^2 $(\ln Z_E)^2$	φ_{EE}	−0.0071	−0.25
½ (ln Marketing experience)^2 $(\ln Z_X)^2$	φ_{XX}	−0.1614***	−6.09
ln Education * ln Marketing experience ($\ln Z_E$ * $\ln Z_X$)	φ_{EX}	0.1114***	2.55
Variance Parameters			
$\sigma^2=\sigma_u^2+\sigma_v^2$	σ^2	1.5571***	86.73
$\gamma=\sigma_u^2/(\sigma_u^2+\sigma_v^2)$	γ	0.99***	184.23
Log likelihood			
Inefficiency effects			
Constant	δ_0	−1.3822	−1.06
Age	δ_1	0.0081	0.40
Main occupation is farming	δ_2	−1.4789***	−2.79
Gender	δ_3	−0.7490	−1.32
Credit received	δ_4	0.1594	0.31
Subsistence pressure	δ_5	0.1239	1.05
Central delta region	δ_6	1.4266**	2.46
North delta region	δ_7	−1.4469*	−1.65
Number of observations		105	

Note: *** significant at 1 percent level ($p<0.01$).
**significant at 5 percent level ($p<0.05$).
*significant at 10 percent level ($p<0.10$).

result. To be consistent with theory, we expect the signs of the price variables to be negative, i.e., rise in input prices reduce marketing margin. Although signs of the fixed factors cannot be determined *a priori,* we expect a positive influence of marketing experience and education on marketing margin. The significance of the interaction term implies that there are non-linearities in the marketing structure and hence justifies the use of translog profit frontier model.

Based on the estimates of the profit frontier function, we computed basic features of the marketing structure, namely, profit/marketing margin elasticities with respect to changes in variable input prices and fixed factors. All the price variables and the fixed factors are mean corrected ($P_{ij}-\overline{P}_j; Z_{il}-\overline{Z}_l$)so that the coefficients on the first order terms can be read directly as elasticity of marketing margin. Table 4 clearly shows that the signs of the coefficients on the price variables are negative, consistent with theory, and the fixed factors have the expected positive signs. The purchase price of cassava product has a dominant impact on the marketing margin. The value of the coefficient on purchase price is –1.65, which is the elasticity value and is substantial. The implication is that a 10% rise in purchase price of N 5.3 per kg of cassava and its products will reduce marketing margin by 16.5% estimated at N 36,053.5 per marketer. The marketing cost per unit also significantly influence marketing margin but the effect is relatively low, 0.39%. The sale price elasticity is computed as 3.04 (=1+1.65+0.39) and is the most dominant factor in improving marketing margin as expected[7]. The implication is that a 10% rise in sale price of N 8.5 per kg of cassava and its product will increase marketing margin by 30.4% estimated at N 66,425.8 per marketer. Marketing experience significantly improve marketing margin (0.02%) but education has no significant influence.

Determinants of marketing efficiency of cassava and its products

Prior to the discussion of factors influencing marketing efficiency, we present the distribution of marketing efficiency scores of the marketers. The mean level of marketing efficiency is estimated at 55% implying that marketing margin can be substantially increased up to 45% by eliminating inefficiency arising out of inappropriate allocation of resources, response to prices and scale of operation. A total of 52.4% of the marketers are operating at efficiency level of up to 50% which explains the very low level of mean marketing efficiency of these marketers (Table 5).

A total of seven variables representing firm-specific socio-economic factors were used to identify the determinants of marketing inefficiency of cassava and its products. The lower panel of Table 4 presents the results. Results show that marketers whose main occupation is farming (i.e., farmers) are relatively efficient. Gender and subsistence pressure (i.e., family

[7] The sale price elasticity $\eta_p=1+\sum\eta_{wi}$, where η_{wi} is the *ith* purchase price elasticity.

Table 5: Distribution of marketing efficiency scores of cassava and cassava products

Efficiency range	
Up to 50%	52.4
51–60%	12.4
61–70%	1.9
71–80%	6.7
81–90%	5.7
91–100%	21.0
Efficiency measures	
Mean score	0.55
Standard deviation	0.29
Minimum	0.02
Maximum	1.00
Number of observations	105

size) have no significant influence on marketing efficiency. Marketers located at the Northern Delta region are relatively efficient whereas those in Central Delta region are relatively inefficient relative to marketers in Southern Delta whose effects are subsumed in the constant term of the model.

4. Discussion and policy implications

The present study examines the level of marketing margin, marketing efficiency and its determinants of cassava and its products by applying a stochastic profit frontier approach on a survey data of 105 marketers from three regions of Delta State, Nigeria.

Results reveal that marketing margin per kg varies significantly across products and is highest for tapioca followed by cassava flour and lowest for cassava root tuber. The main contributor to marketing margin is the difference between the purchase and sale prices of the products, particularly those with advanced level of processing (e.g., tapioca). For example, the average marketing margin per kg of tapioca is N 124.93 whereas for cassava root tuber it is only N 5.19 per kg. This point towards the importance of processing cassava into its value added products to generate higher revenue for the processors as well as marketers. That is a high purchase price of processed products benefits processors/farmers whereas a high sale price of the products benefits marketers. However, on the other hand, Table 2 shows that the highest amount of product traded by each marketer is gari (3,429.4 kg). But marketing margin generated from selling gari is second lowest (Table 1), which is the most popular form of processed cassava. Therefore, the reason for its popularity may lie with the fact that trading in gari requires relatively less upfront investment as compared to other processed products (e.g., tapioca, flour), and yet generates three times more return as compared to selling raw cassava root tuber which requires no processing but is bulky and highly perishable. In fact, 86.5% of the marketers in the survey responded that the main source of their marketing capital is personal savings. This is because although 42% of marketers responded that they had access to some form of credit, the amount from such credit may have been highly inadequate or it was used for other purposes. Also, only 16% of cassava root tuber is processed for industrial use and/or export (Nweke, 2004) which in turn is dominated by gari perhaps.

A rise in the sale price of cassava products boost marketing margin whereas increases in purchase price of cassava products as well as unit marketing cost significantly reduce marketing margin, as expected. The responses to purchase and sale prices of cassava products are in the elastic range (i.e., profit elasticity –1.65 for purchase price and 3.04 for sale price of cassava products), implying that movements in cassava prices exert substantial influence on marketing margin. Rahman (2003) reported profit elasticities of –0.92 for a rise in input prices (a total of five inputs) and 1.92 for a rise in output price for rice production in Bangladesh.

Significantly positive influence of marketing experience on marketing margin implies that the trade of cassava products requires relevant skills and knowledge about the products acquired mainly through long years of experience. Therefore, any new entrants in this trade will need to overcome the lack of experience through training. Lack of significance of education on marketing margin reinforces the mixed influence of education on efficiency and/or productivity in the agricultural sector. For example, Aye and Mungatana (2011) found significant influence of education on maize production efficiency in Nigeria, but Gelan and Muriithi (2012) did not find any significant influence of education on dairy farm efficiency in East Africa. Also, Asadullah and Rahman (2009) found significant influence of education on rice productivity in Bangladesh but we did not find such influence on profitability in our results.

Results also show that the farmers as marketers are more efficient. The implication is that cassava farmers perform better than general traders in marketing of cassava products as they are well aware of the various aspects of the products, e.g., quality, colour, smell, moisture content, and other attributes. Gender of marketers has no influence on marketing efficiency implying that the relative efficiency of male or female marketers are same. Whether women are more or less efficient than men in farming is a hotly debated issue and results vary among the few studies that were undertaken in Africa during the 1990s (Adesina and Djato, 1997). For example, Adesina and Djato (1997), using a deterministic profit function analysis, concluded that the relative degree of farming efficiency of women is similar to that of men in Cote d'Ivoire, which conforms to our result. Also, marketers located in Central Delta state are relatively inefficient whereas those in North Delta are efficient relative to marketers in South Delta. The reasons may lie with respect to differences in prices, market structure and other unexplained factors. It was observed that the quantity of products traded, unit marketing cost, prices and gross margin are significantly lower in Central Delta region as compared with other two regions.

A number of policy implications can be drawn from this study. Although price for cassava and cassava prices in Nigeria are determined by market forces, high fluctuation in prices (both sale and purchase prices) indicates that the market is not functioning properly. Lack of marketing and processing facilities, inadequate marketing infrastructure, poor road network and transportation facilities were reported as the major constraints by these marketers. All of these factors adversely affect supply of cassava and its products coming to the market and may result in fluctuation in purchase and sale prices, marketing costs and marketing margin. Therefore improvements in marketing infrastructure will address these issues and also reduce unit marketing cost which will in turn improve marketing margin. Results also showed that marketing experience significantly improve profitability. One way to improve marketing experience is through building capacity of the marketers. Therefore, investment in training targeted at cassava and cassava product marketers will improve marketing margin. The aforementioned policies needs to be supplemented by region specific measures aimed at improving overall market functions so that the observed regional differences can be reduced.

Although meeting all these policy options are formidable, but effective implementation of these policy measures will increase profitability of marketing cassava and its products that could contribute positively to agricultural growth in Nigeria.

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