Vertical Differentiation of Cassava Marketing Channels in Africa

A.A. Enete*

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Summary

Farming systems in sub-Saharan Africa are inherently risky because they are fundamentally dependent on vagaries of weather. Sub-Saharan Africa is also a region in crises; poverty, civil strife and HIV/AIDS. Attention must therefore be focused on improving the production and marketing of crops that could thrive under these circumstances. Because of its tolerance of extreme drought and low input use conditions, Cassava is perhaps the best candidate in this regard. And cassava is a basic food staple and a major source of farm income for the people of the region. Efficiency in cassava marketing is a very important determinant of both consumers' living cost and producers' income in Africa. Vertical differentiation of marketing channels improves marketing efficiency. Identified in this paper are factors that drive vertical differentiation of cassava marketing channels. The paper is based on primary data collected within the framework of the Collaborative Study of Cassava in Africa. High population density, good market access conditions, availability of mechanized cassava processing technology and cassava price information stimulate vertical differentiation of the marketing channels.

Résumé

Différentiation verticale des chaînes de commercialisation de manioc en Afrique

A cause du fait qu'ils dépendent principalement des aléas climatiques, les systèmes de culture en Afrique sub-Saharienne sont soumis au risque. L'Afrique sub-Saharienne est une région en crise, en pauvreté, souvent en conflit civil et sous le fléau du SIDA. Il faut alors l'amélioration des systèmes de production et de commercialisation de cultures qui peuvent encore pousser dans ces circonstances. A cause de sa capacité de production en période de sécheresse et dans des conditions dures, le manioc peut être le meilleur candidat à cet égard. Le manioc est un produit de base et une source importante de revenu agricole pour la population de la région. L'efficience dans la commercialisation du manioc est un déterminant important du coût de la vie des consommateurs et des revenus des producteurs en Afrique. La différentiation verticale des chaînes de commercialisation améliore l'efficience de la commercialisation. Dans cette étude, on a identifié les facteurs qui déterminent la différentiation verticale des chaînes de commercialisation de manioc. L'étude est basée sur des données primaires collectées dans le cadre de l'étude collaborative sur le manioc en Afrique. Une grande densité de population, de bonnes conditions d'accès au marché, la disponibilité de technologie mécanique de transformation de manioc et l'information sur les prix de manioc poussent la différentiation verticale dans les chaînes de commercialisation.

Introduction

Cassava is a basic food staple, and a major source of farm income for the people of sub-Saharan Africa. It contributes about 40% of the food calories consumed in Africa (12) and both rich and poor farmers often derive more cash income from cassava than from any other crop or income earning activity (2, 16, 23). Hence, efficiency in cassava marketing is an important determinant of both consumers' living cost and producers' income. Moreover, as the process of urbanization progresses in Africa, an increasing share of national food consumption takes place at locations other than where food is produced. The marketing system must develop well to provide necessary services as producers sell in markets distant from where consumers buy their food (9). Yet, compared with cassava production, cassava marketing has received much less than sufficient attention (9, 22). There is however an inter-acting and mutually reinforcing relationship between increased production and efficient marketing (19). Efficient marketing systems stimulate increased production, and the reverse constitutes a constraint to any development effort (18). A malfunctioning marketing chain constitutes an impediment to food security as investment in production becomes both more costly and more risky and may end up being wasted (9). More efficient distribution methods and facilities could reduce the costs of distribution, decrease the spoilage of good food, and lessen the severity of food shortage, which could improve the lives of millions of people in Africa, who face starvation, malnutrition and short life expectancy (15).

The mediation of marketing intermediaries between the producer and consumer of food, improves efficiency and reduces distribution costs to all market participants (1, 4), and these indices get better as the number of intermediaries increases and vertically differentiate into specialised functions like wholesale and retail. Vertically differentiated marketing channels reduce transaction costs of marketing especially for producing households (6). The objective of this paper is to identify factors that drive vertical differentiation of cassava marketing channels. The paper is based on primary data collected as part of the collaborative study of cassava in Africa (COSCA).

Methodology

Site and sample selection

Climate, human population density, and market infrastructure formed the basis for sampling. Four basic climatic zones were defined from temperature and duration of dry periods within the growing season (Table 1).

Information available on all-weather roads, railways, and navigable rivers derived from the 1987 Michelin travel maps was used to divide a market access infrastructure map of Africa into good and poor zones according to the density of the roads, railway, or navigable waterways. Human population data from the United States Census Bureau were used to divide a population map of Africa into high demographic-pressure zones with 50 or more persons per km^2, and low, if less.

*Department of Agricultural Economics, University of Nigeria, Nsukka, Nigeria.
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Table 1
Definitions of climatic zones

Climatic zone	Temperature (ºC) Daily mean	Temperature (ºC) Range	Months of dry season
Lowland humid	>22	<10	<4
Highland humid	<22	<10	<4
Subhumid	>22	>10	4 – 6
Non – humid	>22	>10	6 – 9

The three maps of climate, human population density, and market access infrastructure were overlaid to create zones with homogeneous climate, demographic pressure, and market-access conditions. Each climate/population density/market-access zone with less than 10,000 ha of cassava in each country was excluded. The remaining areas were divided into grids of cell 12' latitude by 12' longitude to form the sample frame for site selection. 282 grid cells, distributed among the climate/population density/market-access zones in proportion to the zone size were randomly selected in each country, depending on the size of the country. These are 71 from Congo Democratic Republic, 40 from Ivory Coast, 30 from Ghana, 65 from Nigeria, 39 from Tanzania and 37 from Uganda. A village was then randomly selected in each grid. This brings the number of villages selected in each country just equal to the numbers listed above. In each selected village, with the assistance of key village informants, a list of farm households was compiled and grouped into "large", "medium", and "small" farm-holder units, and the major market serving the village identified and all traders that sold cassava in the identified village market at the time of survey were used.

Data collection

Leaders in cassava research in the national agricultural research systems in each country administered survey questionnaires to respondents and took various measurements. A rapid rural appraisal technique was employed to collect village-level information in the Phase I survey. Farmer groups consisting of men and women with a wide range in age were constituted and interviewed in each village. A structured (organized from production through processing to marketing) questionnaire was used to collect qualitative information on the following aspects: (a) various production practices, (b) cassava processing methods including cassava products processed, (c) cassava marketing including cassava products marketed, points of sale and type of buyers, (d) village level altitude; mid-altitude refers to all the sampled villages that are more than 800 m above sea level and low altitude refers to all villages less or equal to 800 m above sea level. This survey was conducted in 1989-1991.

Phase II survey was aimed at detailed characterization of the cassava production methods at the field-level. The field-level information which was collected from all crop fields of the selected farm units included, field history, inputs applied, cassava root yield and field size. This information was collected in 1991 from the same villages as in phase I.

Phase III survey was at the household and rural market level, also in the same villages. Cassava traders in identified rural markets serving each of the COSCA villages and relevant male and female household members were interviewed with structured questionnaire and relevant measurements taken. The information collected included type of cassava products traded, sources of purchases and outlets of cassava products, volume traded, access to cassava price information in locations other than where traded. This information was collected in 1992.

Estimation procedure

We distinguish three steps in the vertical differentiation process. A step is assigned one if a cassava farmer just sold his cassava directly to the consumer; assigned two if one level of intermediary (retailer for example) came between the farmer and the consumer; and three if more than one stage of intermediaries came between the farmer and the consumer. This later stage is when the traders differentiate into wholesalers and retailers. There were situations where more than one wholesale level were involved, but following Dijkstra (6); we assign step three to every category with at least one wholesale level. With these three possible options (step 1, 2 and 3) defined for the marketing channels, we also follow Dijkstra's approach by using multinomial logit model for the analysis. The dependent variable can therefore assume 1 (farmer sells cassava directly to consumer), 2 (farmer sells to retailer who then sells to consumer) or 3 (farmer to wholesaler to retailer and to consumer). In the multinomial logit model, a set of coefficients $\beta^{(1)}$, $\beta^{(2)}$, $\beta^{(3)}$ corresponding to each outcome category can be estimated as:

$$\Pr(Z=1)=\frac{e^{x\beta^{(1)}}}{e^{x\beta^{(1)}}+e^{x\beta^{(2)}}+e^{x\beta^{(3)}}}$$

$$\Pr(Z=2)=\frac{e^{x\beta^{(2)}}}{e^{x\beta^{(1)}}+e^{x\beta^{(2)}}+e^{x\beta^{(3)}}}$$

$$\Pr(Z=3)=\frac{e^{x\beta^{(3)}}}{e^{x\beta^{(1)}}+e^{x\beta^{(2)}}+e^{x\beta^{(3)}}}$$

The model however is unidentified in the sense that there is more than one solution to $\beta^{(1)}$, $\beta^{(2)}$, $\beta^{(3)}$ that leads to the same probabilities for Z= 1, Z= 2 and Z= 3. To identify the model, one of $\beta^{(1)}$, $\beta^{(2)}$, $\beta^{(3)}$ is arbitrarily set to 0. That is, if we arbitrarily set $\beta^{(3)}= 0$ the remaining coefficients $\beta^{(1)}$, $\beta^{(2)}$ would measure the change relative to the Z= 3 group. In other words, we would be comparing the most vertically differentiated channel (3) with the less differentiated ones (1 & 2). Setting $\beta^{(3)}= 0$, the above equations become:

$$\Pr(Z=1)=\frac{e^{x\beta^{(1)}}}{e^{x\beta^{(1)}}+e^{x\beta^{(2)}}+1}$$

$$\Pr(Z=2)=\frac{e^{x\beta^{(2)}}}{e^{x\beta^{(1)}}+e^{x\beta^{(2)}}+1}$$

$$\Pr(Z=3)=\frac{1}{e^{x\beta^{(1)}}+e^{x\beta^{(2)}}+1}$$

The relative probability of Z= 1 to the base category is

$$\frac{\Pr(Z=1)}{\Pr(Z=3)} = e^{x\beta^{(1)}}$$

Call this the relative likelihood and assume that X and $\beta_k^{(1)}$ are vectors equal to (x_1, x_2, …; x_k) and ($\beta_1^{(1)}$, $\beta_2^{(1)}$, …, $\beta_k^{(1)}$) respectively. The ratio of relative likelihood for one unit change in x_i relative to the base category is then

$$\frac{e^{\beta_1^{(1)} + \ldots + \beta_i^{(1)}\left(z_i+1\right) + \ldots + \beta_k^{(1)} x_k}}{e^{\beta_1^{(1)} x_1 + \beta_i^{(1)} x_i + \ldots + \beta_k^{(1)} x_k}} = e^{\beta_i^{(1)}}$$

Thus, the exponential value of a coefficient is the relative likelihood ratio for one unit change in the corresponding variable (21).

Variable definition

From the foregoing, the dependent variable in this estimation is defined to have three possible values: 1 (Channel step 1), which denotes channels where the farmer sells directly to the consumer; 2 (Channel step 2), denoting channels where only one marketing intermediary came between the farmer and the consumer; and 3 (Channel step 3), which denotes channels where more than one intermediary came between the farmer and the consumer. The latter category is where the marketing channel has vertically differentiated into specialised functions like wholesale and retail.

Vertical differentiation of cassava marketing channels may be related to population density, market access conditions, type of cassava products traded, availability of mechanized cassava processing technology and cassava price information.

Population density (POPDEN) generally reflects the level of consumer demand in an area. A high population density would therefore imply a high output for the marketing channel in the area. Food marketing channels differentiate vertically with market size, where size is defined in terms of market output (3, 6). Similarly, market access conditions are likely to affect the rate of turnover of the intermediaries in the system, and hence the extent of vertical differentiation of the marketing channels. Market access conditions are here classified into four categories: motor vehicle as a means of access to market (MKTACC2), other vehicles like bicycles, carts, animals, boats, etc... (MKTACC3), foot with a distance of less or equal to 10 km (MKTACC1), and foot with a distance of more than 10 km (MKTACC4) as a means of access to the market. For purposes of this analysis, we shall compare MKTACC2, with each of the other three categories.

Type of cassava products traded is likely to affect the number of intermediaries in the channel and hence its vertical differentiation. This is because different types of cassava product vary in terms of moisture content and perishability, hence, not all can be transported over long distances for sale. And transport distances increase the number of marketing intermediaries (1). We distinguish for purposes of this analysis, five major types of cassava products: GRANULES, FRESHROOTS, PASTES, DRIEDROOTS and OTHERS. We shall be comparing the dummy for DRIEDROOTS with the other four products.

Availability of mechanized cassava processing technology (MECHPROC) is expected to be positively related with higher differentiation of cassava marketing channels. Its availability motivates farmers to produce, and hence market more cassava (11). This is likely to encourage the participation of more intermediaries in cassava marketing and hence aid vertical differentiation of the channel. Similarly, availability of information on pries (PRICINFO) of cassava products in different location is also likely to encourage more intermediaries into the cassava markets because the risk of adverse selection is reduced.

We also include a regional dummy (EASTAFRICA) as against West Africa to capture the effect of regional differences on vertical differentiation of cassava marketing channels. The variables are defined in table 2.

Table 2
Definition of variables specified in the regression function of vertical differentiation of cassava marketing channels

Variables	Mean (Std deviation)	Explanation
PODDEN	0.55 (0.50)	I, if population pressure is high; else 0
MKTACC1	0.50 (0.50)	I, if market access was on foot with a distance of within 10 km
MKTACC2	0.38 (0.48)	I, if market access was with motor vehicle; else 0
MKTACC3	0.07 (0.26)	I, if market access was with means like animals, cycles, canoes etc
MKTACC4	0.05 (0.22)	I, if market access was on foot with a distance of more than 10 km
MECHPROC	0.73 (0.44)	I, if mechanized cassava processing technology was available in village; else 0
PRICINFO	0.44 (0.50)	I, if 'trader' had information on prices of cassava products in locations other than where sold
GRANULES	0.37 (0.48)	I, if the major cassava product traded is granules; else 0
FRESHROOTS	0.23 (0.42)	I, if the major cassava product traded is pastes; else 0
PASTES	0.03 (0.18)	I, if the major cassava product traded is pastes; else 0
OTHERS	0.01 (0.07)	I, if the major cassava product traded is others, else 0
DRIEDROOTS	0.36 (0.45)	I, if the major cassava product traded is dried roots; else 0
EASTAFRICA	0.31 (0.46)	I, if country is Tanzania or Uganda; else 0

Results and discussion

Table 3 presents the results of the analysis. The explanatory powers of the factors as reflected by Pseudo-R^2 seem low (23%), but this is not uncommon in cross-sectional analysis. The overall goodness of fit as reflected by Prob> chi^2 was however good (< 0.001). In terms of consistency with a *priori* expectations on the relationship between the dependent variable and the explanatory variables, the model appears to have performed well.

In comparison with low population density, the probability that a marketing channel is step 1 or step 2 as against step 3 was negatively and highly significantly related with high population density. This is consistent with expectation. High population density most often translates into high food demand (7), especially of a basic food staple like cassava in Africa. Because the point and form of food production are not necessarily the point and form of consumption, food must be moved efficiently between production and the rising consumption in order to avoid regions of scarcity developing along regions of surplus within the same society. Population density creates the need for more market intermediaries, and as more intermediaries enter the system, they differentiate into specialised functions (wholesale, processing and retail) for purposes of improving efficiency of distribution.

In comparison with areas where market access was with motor vehicle, the probability of channels (1 or 2) as against 3 was positively related with areas where market access was on foot with a distance of less than 10 km or on foot with a distance of more than 10 km or with any other means like animals, carts, boats etc. This relationship was statistically significant in both step 1 and step 2 equations for the later means of access to the market. While the dummy for areas where the access was on foot with a distance of less than 10 km was significant in step 1 equation, that of areas where it was on foot with a distance of more than 10 km was significant in step 2 equation. Compared to areas where market access was with motor vehicle, other conditions of market access could be said to be poor (8).

These relationships are therefore consistent with our hypothesis. Motor vehicle helps to bring about economies of scale in food distribution and hence encourages vertical differentiation of the marketing channel, as traders specialise in wholesale and retail. In addition, as noted earlier, the rate of turnover and hence market output is likely to be higher where means of access is with motor vehicle than where it is not. We had earlier noted that food marketing channels differentiate vertically with market output.

The probability of marketing channels (step 1 or step 2) as against step 3 was negatively related with availability of mechanized cassava processing technology. This relationship was statistically significant for step 1 equation. Mechanized cassava processing may not only increase the number of intermediaries because processing improves the quality and transportability of cassava products over long distances, but also because it could encourage the emergence of independent cassava processors as a distinct intermediary.

Knowledge of prices of cassava products in different locations was negatively related with the probability of step 1 or step 2 in comparison with step 3. This relationship was significant for step 1 equation. In other words, availability of information on prices of cassava products in different locations stimulates participation of agents and hence vertical differentiation of the marketing channels. One of the implicit assumptions of fundamental welfare theorems is that all characteristics of all commodities are observable by all market participants (14). Without this condition; if it is costly to acquire such information, the well known problem of adverse selection arises thereby discouraging market participation (24). Goetz (10) observed in Senegal that regarding the effects of fixed cost-type variables on market participation, better information plays an important role for sellers.

In comparison with dried roots, cassava fresh roots was positively related with the probability that a marketing channel was step 1 or step 2 as against step 3. This relationship was statistically significant for step 2 equation. Dried roots is a processed cassava product. Processing makes cassava products easier to transport, gives them longer shelf-life, and improves their palatability. Cassava fresh roots on the other hand are very bulky to transport and extremely perishable (17). This suggests that cassava fresh roots are more likely to be sold at or close to the point of production than dried roots, which can be transported farther away. Thus the marketing of dried roots is likely to require more market intermediaries than fresh roots, thereby contributing positively to vertical differentiation of the marketing channels. Nweke (17) reported that the drying process involved in making dried roots facilitates its marketing. Similarly, paste (also a processed product) was positively and significantly related with the probability of channel step 1 as against step 3. Although the processing of cassava into paste particularly wet paste reduces volume and extends shelf-life, it is still bulky and relatively more perishable than dried roots (17). Dried roots should therefore be more amenable to distant (both in terms of time and space) marketing and hence may require more intermediaries than paste.

Table 3
Result of multinomial logit regression analysis of vertical differentiation

Variables	Channel step 1	Channel step 2
POPDEN	-4.900 (-3.727)***	-1.508 (-5.455)***
MKTACC 1	2.207 (2.255)**	0.432 (1.328)
MKTACC 3	4.487 (2.962)***	1.517 (2.798)***
MKTACC 4	1.928 (1.207)	1.419 (2.460)**
MECHPROC	-1.731 (-2.756)***	-0.140 (-0.463)
PRICINFO	-1.128 (-1.657)*	-0.256 (-0.979)
FRESHROOTS	0.703 (0.920)	0.778 (2.408)**
GRANULES	0.426 (0.486)	-0.556 (-1.527)
PASTES	3.518 (3.064)***	-0.237 (-0.272)
OTHERS	3.837 (1.942)**	-37.664 (0.000)
EASTAFRICA[r]	-0.602 (-0.728)	-0.152 (-0.439)
INTERCEPT	-2.477 (-2.208)**	-0.505 (-1.213)
Statistics: Chi^2		138.77
Prob> chi^2		< 0.00
Pseudo R^2		0.227
No. of obs.		424

Notes: Channels step 3 is the comparison group. Figures in parentheses are Z-ratios; *** denotes P≤ 0.01, ** denotes 0.01< P≤ 0.05, and * denotes 0.05< P≤ 0.10, r – regional dummy was used because it provided a better fit than country dummies.

Conclusion

Efficiency in cassava marketing is a very important determinant of both consumers' living cost and producers' income in Africa. Vertical differentiation of marketing channels improves marketing efficiency. Identified in this paper are factors that drive vertical differentiation of cassava marketing channels. High population density, good market access conditions, availability of mechanized cassava processing technology and cassava price information stimulate vertical differentiation of the marketing channels.

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A.A. Enete, Nigerian, Lecturer at the Department of Agricultural Economics, University of Nigeria, Nsukka. Research Fellow with the Collaborative study of cassava in Africa (COSCA), which was based at the IITA, Ibadan, Nigeria. From 1999-2004, he was at the Katholieke Universiteit Leuven, Belgium, where he completed his PhD programme in Agricultural Economics in December 2003.