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Effect of transaction costs on market participation among smallholder cassava farmers in Central Madagascar

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Abstract: High transaction costs deter entry of small farmers into the market. With the data from 240 smallholder cassava farmers in Central Madagascar, this study identified strategies to promote successful smallholder commercialization. The coefficients for membership of cooperatives, native of community and farming experience, have a direct relationship with decision to participate in the market and which is significant at 1% level and road condition to the nearest town is good at 10% level. The coefficients for age, distance to the nearest town and distance from the farm to the market have an indirect relationship with decision to participate in the market and significant at 5, 10 and 1% levels, respectively. The results also show that the coefficients for personal means of transportation and marketing experience have a direct relationship with decision to sell cassava off-farm and at 10 and 1% level of significance, respectively, while distance to the nearest town and distance from the farm to the market had an indirect relationship with decision to sell off-farm at 5% level of significance each and cost of transportation at 1% level. The

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PUBLIC INTEREST STATEMENT

Smallholder cassava farms are characterized by low levels of market participation, transaction costs are difficult to measure, understanding the impact they have on behaviour is important, as it can inform the creation of policies aimed at reducing them. Transaction costs reflect market characteristics in the study area, but are mainly embedded in household characteristics and their economic environment. This study shows how different types of transaction cost influence decisions and outcomes among farm households in Central Madagascar. Improving rural infrastructure such as access roads would help speed-up the delivery of farm products—and in particular perishable commodities such as cassava—to urban consumers. The transaction costs generated by the selling cassava could also be reduced by improving the market information available to the farmers, by deeper penetration of reputable input distributors, and promotion of institutional innovations such as production and marketing cooperatives based on the setting-up of bulking centres.

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study raises policy issues which might reduce these transaction costs by providing more market outlets, better rural infrastructure and also bulking centres.

Subjects: Economics, Finance, Business & Industry; Environment & Agriculture; Environmental Studies & Management

Keywords: rural infrastructure; triple hurdle and Heckman selection

1. Introduction

Cassava (*Manihot esculenta* Crantz) is an important staple food and cash crop in several tropical African countries, where it plays a principal role in food economies. In Madagascar, cassava leaves and roots are treated as edibles, with the roots mainly used to make tapioca and candy. However, cassava itself is mainly used as animal feed, though is very important as it serves as a buffer crop during lean times. Dried cassava is mostly consumed in the southern part of the country which exports cassava to neighbouring islands, but increase in freight and shipping costs eventually made it unprofitable (Fenohasina, 2007).

Total world cassava utilization is projected to reach 275 m by 2020 (IFPRI in Westby, 2008), with some researchers estimating that the number will be closer to 291 m (Scott, Rosegrant, & Ringler, 2000 in Westby, 2008). Africa is the world's largest producer of cassava, with Nigeria leading with 34.17% of the continent's market share. Madagascar produces about 3.11 m of cassava per annum, which is about 1.12, 1.97 and 8.57% of the World's, Africa's and Eastern Africa's total output, respectively (FAO Statistics, 2013). Cassava yields can be quite high, as high as 25–40 t/ha, although nationally, yields are often well below these levels. The world's, Africa's and Eastern Africa's average yields are 13.34, 11.14 and 0.97 t/ha, respectively, while in Madagascar the average yield is 0.65 t/ha (FAO, 2013).

In Africa, most cassava is used for food consumption purposes, and opportunities for commercial development remain largely undeveloped, in contrast to the other major cassava producing regions such as Asia and South America. Insufficient processing options for stored roots, inadequate marketing channels and poor linkages between producers and end users are the major factors preventing greater profitability among producers and processors in Africa (IITA, IITA., 2004). The fact that fresh cassava is both perishable as well as very voluminous determines the behaviour of each group and participant in the cassava market. Local processing and transportation are key services that need to be performed efficiently, and represent key issues within the African cassava value chain (Knipsheer et al., 2007).

Fresh cassava roots—which have a water content of about 70%—are bulky and so expensive to transport, especially over long distances. The roots are also perishable, and begin to deteriorate soon after harvest. These product features have a profound bearing on the trade network for the roots. For instance, the bulky nature of the fresh roots makes the market for them more localized; focused as it is around the production centres (and unlike the processed cassava products which have a wider market coverage geographically). Also, the perishability of the roots means their marketing activities cover a much shorter time frame than those for other cassava products (Ezedinma, Sanni, & Okechukwu, 2007).

Promoting market-orientation among agricultural producers in developing countries, and particularly among smallholder farmers, is pivotal for the development of effective agribusiness value chains, those that can supply adequate food. Such a move involves improving the production and marketing processes for and capacity of income generating processes among resource-poor farmers (Otieno, Omiti, Nyanamba, & McCullough, 2009). The functioning of food markets in many developing countries is hampered by the high costs of market exchange (Bassolet, 2000; Lutz, 1994). The relative magnitudes of these transaction costs depend on farmers' access to infrastructure facilities, and particularly roads (Akramov, 2009), for limited or poor quality road and rail links inhibit timely

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access to inputs, increase input costs and decrease access to output markets, thereby reducing the transmission of market signals (Dayo, Nkonya, Pender, & Oni, 2009).

The issue of how farmers come to the decision on whether to sell at the farm gate or to transport their produce to the market has received little attention in the literature. This is surprising from a policy perspective because the livelihoods of many poor farmers across the world depend on the sale of agricultural commodities for export. Fu, Epperson, Terza, and Fletcher (1988), Fletcher and Terza (1986) and Edelman, Schmiesing, and Olsen (1990) have all shown that farmer characteristics influence farmers' choices on which sales mechanisms to use; however, little has been written on what drives farmers' decisions on this in developing countries.

In developing countries, smallholder farmers find it difficult to participate in the market due to the presence of a range of constraints and barriers which reduce their incentives to participate. Such decisions may be reflected in hidden costs that make access to markets and productive assets difficult (Makhura, Kirsten, & Delgado, 2001). Transaction costs, that is, the observable and non-observable costs associated with exchange, act as the key barriers to market participation for resource poor smallholders (Coase, 1960; Delgado, Rosegrant, Steinfeld, Ehui, & Courbois, 1999; Holloway, Nicholson, Delgado, Staal, & Ehui, 2000; Makhura et al., 2001), and poor infrastructure often increases such market transaction costs (Takeshima, 2008). Meanwhile, the policy analyses carried out thus far on market participation and supply decisions have left considerable scope for further econometric inquiry to take place (Lapar, Holloway, & Ehui, 2003). If transactions costs are high, they need to be measured and explained. de Janvry and Sadoulet (2005) have argued that attempting to observe them directly will always underestimate their importance, quite likely by large amounts. Their study showed; however, that such costs can be derived from observed behaviour. However, to do this requires models to be constructed in which behaviour is specified. Transaction costs reflect the character of the market, but are mainly embedded in household characteristics and their economic environment (Gabre-Madhin, 1999; Holloway et al., 2000; Makhura et al., 2001).

The triple-hurdle model has been applied very little in order to model agricultural commodity supply decisions, and this paucity of use is somewhat surprising. Barriers to entry, whether they be perceived or real, are significant impediments for expanding the density of market participation (Stiglitz, 1989). By examining how small-scale cassava farmers sell their output, we hope to throw some light on how transaction cost levels affect farmers in poor countries. In contrast to farmers in developed countries, who often have large farms and enjoy good institutions and infrastructure, most farmers in developing countries are very small in scale and geographically isolated, and so beyond the reach of formal market institutions (Fafchamps & Hill, 2005). For them, interacting with the market is fraught with difficulty and danger, thereby restricting their agricultural activities to subsistence use only (Fafchamps, 1992 and Key, Sadoulet, & de Janvry, 2000). There has also been little work published on the use of the triple hurdle model, especially in relation to market participation decisions, unlike the double hurdle model which has been used more extensively.

2. The Concept of Transaction Costs

Two broad categories of transaction costs—proportional and fixed transaction costs—can be identified in the literature (Key et al., 2000). Some researchers have broken-down transaction costs into tangible costs (such as transportation, communications and legal costs) and intangible costs (such as levels of uncertainty and moral hazard) (Cuevas & Graham, 1986; Holloway et al., 2000; Birthal, Joshi, & Gulati, 2005). Key et al. (2000) made the distinction between fixed or lump sum transaction costs on the one hand, and variable, proportional or per-unit transaction costs on the other. They showed that both fixed and variable transaction costs impact on market participation levels, whereas supply decisions (the amounts sold)—conditional on market participation, only depend on variable transaction costs.

Most of the previous empirical studies on this topic have used the joint decision model of market participation (using both fixed and proportional transaction costs) and the amounts transacted (which depend on the proportional transaction costs) to identify the presence and level of these two types of transactions cost (Vakis, Sadoulet, & de Janvry, 2003). Goetz (1992); meanwhile, identified the presence of transaction costs by highlighting some of their determinants as regressors in market participation and quantity transacted equations, used for the peanut market in Senegal. As did Skoufias (1995) for the land rental market in Peru and Sadoulet, de Janvry, and Benjamin (1998) for the labour market in rural Mexico.

Takeshima (2008); meanwhile, adhered to the conventional Heckman sample selection approach for the following reasons. The stochastic threshold approach used by Key et al. (2000) requires that prices are reported for all observations, and this did not match with the data-set used by Takeshima, which reported prices only for sellers and buyers. The Bayesian approach offered by Holloway, Barrett, and Ehui (2005) can be complex when applied to estimations using dual selection criteria, which Takeshima focused on. Also, the studies of Key et al. (2000) and Vakis et al. (2003) employed models in which the unobserved proportional transaction costs are approximated as linear functions of a set of explanatory variables, including reported proportional transaction costs (PTCs). While Key et al. (2000) simply added those PTC-related explanatory variables to the structural equation, Vakis et al. (2003) regressed the reported PTCs on to other PTC-related explanatory variables, to obtain predicted PTCs. Henning and Henningsen (2007) followed Key et al. (2000), although referring to Vakis et al. (2003) when selecting PTC-related variables. Takeshima, (2008) followed Key et al. (2000) by arguing that their approach is more robust when using the functional form of PTCs, and that the estimation routine is less complicated.

Complementing this approach, some studies have analysed the transaction costs that enter into idiosyncratic price formation, with Escobal (Escobal D'Angelo, 2000) using a hedonic price equation among a household sample in Peru, and Staal, Delgado, and Nicholson (1997), the same among milk producers in Kenya and Ethiopia, Park, Jin, Rozelle, and Huang (2002) identifying price differentials across a number of Chinese provinces, and Minten and Kyle (1999) surveying traders in Kinshasa.

Proportional and fixed transaction costs can be separately identified, even when they share the same determinants, through the estimation of a minimum threshold level for the transactions, as implied by the presence of fixed transaction costs. This is done by estimating a censored regression using an unobserved threshold, as Cogan (1981) did among married female workers in the USA, Key et al. (2000) and Makhura et al. (2001) did for the corn market in Mexico and South Africa, respectively, and Henning and Henningsen (2007) applied to labour markets in Midwest Poland. The last study provided a measure for proportional transaction costs, but only revealed the presence and determinants of fixed transaction costs, without taking them into account within the calculation. Finally, one can choose between different markets with different transaction cost structures to reveal the role these costs play in the making of market choices, as Hobbs (1997) did for the cattle market in the USA.

2.1. Theoretical Framework

We identified the theoretical model that best describes the behaviour of the study for cassava farmers, and this guided our empirical analysis. To formally derive this model, we started with the market participation decision, and followed this with the traditional model described by Key et al. (2000), Bellamare and Barrett (2006), Renkow, Hallstrom, and Karanja (2004), Makhura et al. (2001), Holloway et al. (2005), Takeshima (2008) and Burke (2009). All these studies posit that a representative agent will maximize his or her utility (2.1) subject to (2.2) through (2.4).

$$\text{Max } u(c) \tag{2.1}$$

Subject to

$$\sum_{t=0}^{2}\sum_{j=1}^{K}\{[(p_j^m - t_{pj}^s)I_j^{\text{offfram}}(z_t^s)(\delta_j^s) + (p_j^m I_j^{\text{onfarm}} + (p_j^m + t_{pj}^b)I_j^{\text{buyer}}(z_t^b)(\delta_j^b)]m_j - t_{fj}^s(z_t^s)\delta_j^s - t_{fj}^b(z_t^b)\delta_j^b + T\} = 0 \tag{2.2}$$

$$q_j - n_j + A_j - m_j - c_j = 0, \quad j = 1, \ldots, J \tag{2.3}$$

$$G(q,\ n,\ z_q) = 0 \tag{2.4}$$

$$c_j,\ q_j,\ n_j \geq 0 \tag{2.5}$$

In Equation 2.1, u is the agent's utility as a function of a vector of his or her consumption c. Equation 2.2 is the budget constraint, and this is where the role of transaction costs is introduced. Here, p_m^j is the market price of good j, and m_j is the quantity of good marketed, which is positive for sellers and negative for buyers. The agent's role in the market is represented by two indicator functions: δ_j^s is 1 for sellers of good j, and 0 otherwise, and δ_j^b is 1 for buyers of good j and 0 otherwise. Note the additional, important condition:

$$\delta_j^s + \delta_j^b \leq 1 \tag{2.6}$$

This last condition establishes m as the net quantity marketed, by stating that a household cannot be both a buyer and seller during the same period. In this equation, the proportional transaction costs for sellers of good j, t_{pj}^s, and the fixed transaction costs for sellers of good j, t_{fj}^s, effectively change the price they receive and; thus, their market behaviour. Similarly, the proportional transaction costs for buyers of good j, t_{pj}^b, effectively change the price they pay and so their market behaviour also. However, as the authors point out in their separate studies, these transaction costs are largely unobserved within the survey data, and so are represented as a function of those more readily enumerable factors able to explain them, these being z_t^s and z_t^b, respectively. One of the reasons why transactions costs are such an important element in this model, is their role in explaining the level of self-sufficiency seen among producers. The inclusion of non-market transfers, T, which can be positive or negative, completes this constraint.

Equation 2.3 is a feasibility constraint which indicates that for any good j, the amount consumed, c_j, the amount marketed m_j and the amount used as an input, n_j, cannot exceed the amount produced, q_j and the endowment A_j.

Equation 2.4 describes the relationship between inputs, n_j, and outputs, through the use of production technology G, and considering other supply shifters, z_q. Recall that by this stage, production decisions regarding n_j have already been made, so we take n_j as a given. Traditionally, specifications of z_q have been limited primarily to community level characteristics, such as the proportion of local farmers using fertilizer or hybrid seeds, as in Burke (2009), and endowments over which the household has little control, such as age of the household head and/or the amount of land cultivated, as with Key et al. (2000).

Indirect utility functions are derived from Equation 2.4, leading to market quantity functions, as in Key et al. (2000) and Burke (2009), arriving at the decision rules:

$$m_s = q - c = m_s(z_t^s, n, p^m, T, A), \text{for net sellers, and} \tag{2.7}$$

$$m_b = c - q = m_b(z_t^b, n, p^m, T, A), \text{for} \quad \text{net buyers} \tag{2.8}$$

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Notice that, like Bellemare and Barrett (2006) and Key et al. (2000), empirically we separate the positive and negative values of the marketed quantity into two non-negative variables for net purchases m_b, and net sales m_s. Allowing quantities to be determined by separate processes. This makes the model used here more flexible than if we were to use a switching regression, like Goetz (1992).

It is important to note that there are three time periods: $t = 0$, $t = 1$ and $t = 2$, and in each of these periods there is a corresponding utility measure $u(c)$. During period $t = 0$; for example, a producer chooses one regime out of two, namely to sell by participating in the market or not to sell based on the relevant farmer or market characteristics. The producer, after deciding to become a seller, decides to choose $t = 1$; whether to be an on-farm seller or an off-farm seller, based on some characteristics of himself or the market. The seller decides on the quantity to produce and the inputs used based on the expected cassava price and input costs during $t = 2$. If the seller makes decisions sequentially, then $I^R_{\text{cassava}, 0} = I^R_{\text{cassava}}$ and $1 = I^R_{\text{cassava}}, 2$, with $I^S_{\text{cassava}}, 1 = I^S_{\text{cassava}}, 2$ and $q_{\text{cassava},0} = m_{\text{cassava},0} = q_{\text{cassava},1} = m_{\text{cassava}}$ and $1 = 0$. $I^S_{\text{cassava}}, 0$ remaining undefined, since a producer does not decide which seller to be before deciding whether to be a seller at all in period $t = 0$. Therefore, the regime choices are made only in $t = 0$ and $t = 1$, while cassava production, sales and consumption choices are made only in $t = 2$.

3. Methodology

3.1. The Study Area

Madagascar is the largest island in Africa and the fourth largest in the world. With a size of 587,040 sq km, it is approximately twice the size of Arizona and has limited freshwater resources, as water covers only about 1% of the total land surface (FEWSNET, 2012). Agriculture in Madagascar is heavily influenced by rainfall, which is generally abundant along the whole of the east coast, decreases sharply moving into the highlands, and falls to less than 500 mm per year in the south and south-west. The first rains arrive in October or November. The cropping calendar varies greatly from region to region and according to the different climatic conditions, soils and altitude found in each. Food crop production is the most important agricultural sub-sector, accounting as it does for around 75% of the cultivated area. Rice is the staple food, and rice paddies cover 1.34 million hectares throughout the country—with the exception of some semi-arid areas in the south and south-west—under both rain-fed and irrigated systems. Other food crops grown include; maize (mainly in the south and central-east regions, cassava, sorghum (in the south), beans, groundnut, sweet potatoes and a wide variety of vegetables. Nonetheless, the risk-coping strategies used by farmers, including the use of cassava as an energy-giving food, are insufficient to make the farmers food secure (Harvey et al., 2014; Ramaroson Rakotosamimanana, Arvisenet, & Valentin, 2014), and cassava farmers—similar to other farmers—suffer significant losses due to recurrent cyclones.

3.2. Sampling Procedure

A multistage randomized sampling technique was used to select 240 cassava farmers for detailed study. During the first stage, six districts were randomly selected from Central Madagascar, these being Moramanga, Betafo, Ambalavao, Soavinandriana, Analamanga and Vakinankara. These districts are located along the western coast near the Mozambique Channel and along a transverse section of the country which runs through the central region and on to the east coast (Figure 1). During the second stage, two communes were randomly selected from each district, giving a total of 12 communes, then for the last stage, 20 farmers were randomly selected from each commune, giving a total of 240 farmers. Primary data was collected with the aid of a well-structured questionnaire (Figure 2).

3.3. Analytical Procedures

In order to develop the conceptual framework, the following estimation procedure was used.

The market participation equation and seller-type equation by the use of the linear probability model each. The level of participation for on-farm and off-farm sellers, and for all the participants,

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Figure 1. Graphic illustration of the three-tiered market participation model.

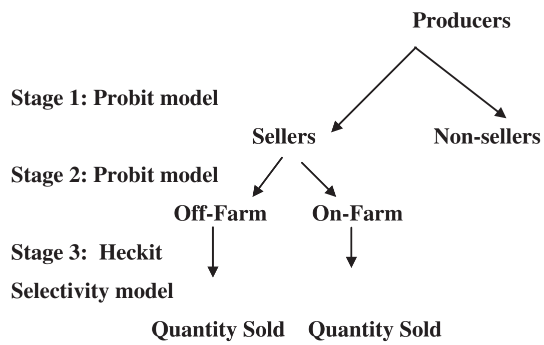
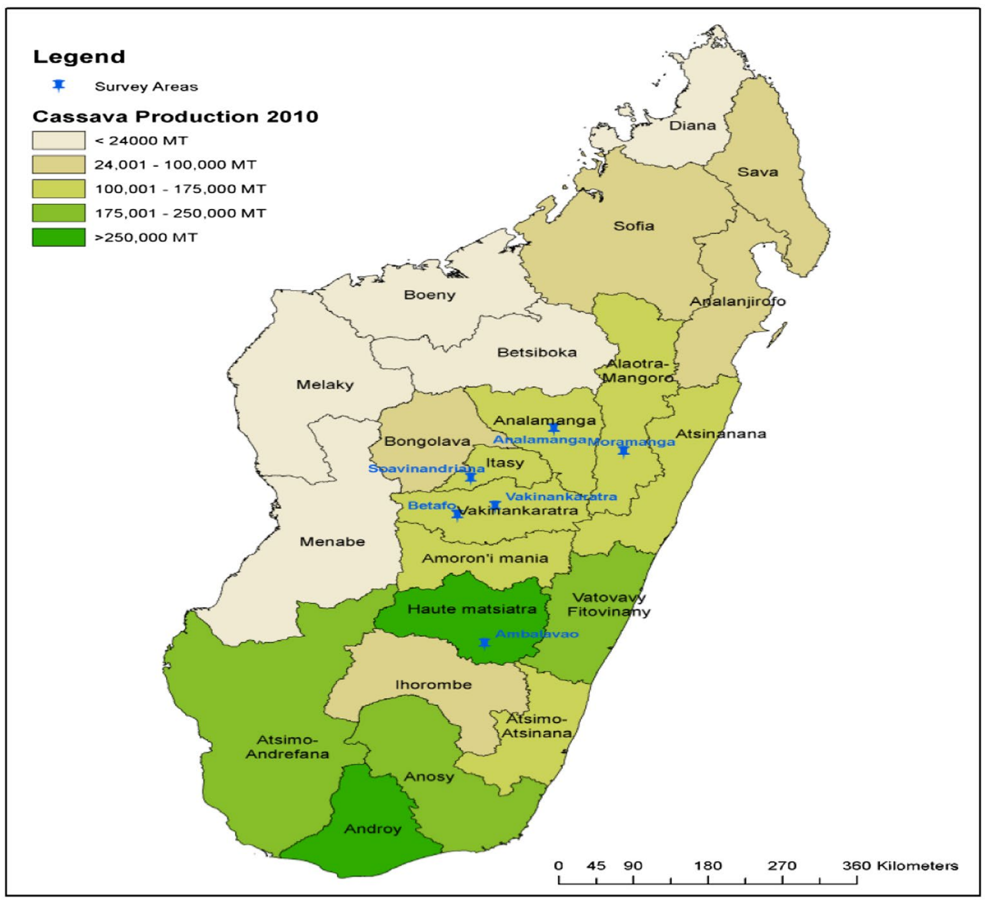


Figure 2. Map of Madagascar showing the survey location.



was calculated using the Heckman selectivity model, following Makhura (2001). These models are specified as follows;

$$\text{Probit}_i^{(\text{seller,non-seller})} = b_0 + b_i X_i + u_i \tag{2.9}$$

$$\text{Probit}_i^{(\text{seller type})} = a_0 + a_i X_i + u_i \tag{2.10}$$

$$\text{Cassava value}^{(\text{seller type})} = \alpha_o + \alpha_i X_i + u_i \tag{2.11}$$

where

$\text{Probit}_i^{(\text{seller,non-seller})}$ = seller = 1, and Non-Seller = 0

$\text{Probit}_i^{(\text{seller type})}$ = probit (on-farm seller = 1, and off-farm seller = 0)

$\text{Cassava value}_i^{(\text{seller type})}$ = value of cassava sold in Ar

b_0 = constant for market participation equation

a_0 = constant for seller-type equation

α_o = constant for the level of participation equation

X_i = variables for estimation

b_i = vector of parameters to be estimated for market participation

a_i = vector of parameters to be estimated for seller type

α_i = vector of parameters to be estimated for level of sales

u_i = error term

Explicitly,

The market participation equation used was modelled as follows:

$$\begin{aligned}\text{Probit}^{(\text{seller,non-seller})} &= b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 \\ &+ b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + b_{14}X_{14} + b_{15}X_{15} + b_{17}X_{17} + b_{18}X_{18} + u\end{aligned} \quad (2.12)$$

And,

The seller-type equation for cassava selling households was modelled as follows:

$$\begin{aligned}\text{Probit}^{(\text{sellertype})} &= a_0 + a_{10}X_{10} + a_{11}X_{11} + aX + 12 + a_{13}X_{13} + a_{14}X_{14} + a_{15}X_{15} \\ &+ a_{16}X_{16} + a_{17}X_{17} + a_{18}X_{18} + u\end{aligned} \quad (2.13)$$

where

X_1 = membership of cooperatives (dummy variable; I = member, 0 = non member)

X_2 = access to communication facilities (dummy variable; 1 = yes, 0 = no)

X_3 = Level of education (in years)

X_4 = gender (dummy variable; 1 = male, 0 = female)

X_5 = age of household head (in years)

X_6 = native of community (dummy variable; 1 = native, 0 = otherwise)

X_7 = farming experience (in years)

X_8 = time to getting paid (days)

X_9 = number of times payment requested

X_{10} = personal means of transportation (dummy variable; 1 = yes, 0 = no)

X_{11} = distance to nearest town (km)

X_{12} = distance from the farm to the market (km)

X_{14} = household size

X_{15} = road conditions to nearest town (dummy variable; 1 = good, 0 = bad)

X_{17} = Farm income in Ar

X_{18} = Cassava yield (t/ha)

b_1–b_{18} = coefficients estimated

a_{11}–a_{18} = coefficients estimated

$U_{i\,=}$ error term

The next procedure identified those factors that influence the amount of cassava sold. It was conjectured that variable transaction cost factors influence participation levels. These models were estimated using the second stage of selectivity (Heckman) model and involved the inclusion of a variable to absorb selectivity bias (Makhura et al., 2001), remembering that the aim of the exercise was to identify factors that increase the level of market participation. Ideally, the OLS model is applicable when all households participate in the market; however, this is rare, as some households may prefer not to participate in a particular market, in favour of another one, while others may be excluded by market conditions. If the OLS regression is estimated while excluding non-participants from the analysis, a sample selectivity bias is introduced into the resulting model. Such a problem is overcome by following a two-stage procedure, as suggested by Heckman (1979), or by following the Tobit procedure.

The participation levels equation for on-farm (2.14) and off-farm (2.15) cassava sellers in this study was specified as follows:

$$\text{Cassava value}_i^{(\text{on-farm})} = \alpha_0^h + ptc_i^R + u_i^h \tag{2.14}$$

$$\text{Cassava value}_i^{(\text{off-farm})} = \alpha_0^h + ptc_i^R + u_i^h \tag{2.15}$$

where

$\text{Cassava value}_i^{(\text{on-farm})}$ = value of on-farm cassava sales in Ar

$\text{Cassava value}_i^{(\text{off-farm})}$ = value of off-farm cassava sales in Ar

ptc_i^R = proportional transaction cost-related variables, as in Equation 2.13

u_i^h = error term

Explicitly, the participation equation for cassava sellers was modelled as follows:

$$\begin{aligned}\text{Cassava value}^{(\text{seller type})} = {} & \alpha_0 + a_{10}X_{10} + \alpha_{11}X_{11} + \alpha_{12}X_{12} + \alpha_{13}X_{13} + \alpha_{14}X_{14} + \alpha_{15}X_{15} + \alpha_{16}X_{16} \\ & + \alpha_{17}X_{17} + \alpha_{18}X_{18} + u\end{aligned} \tag{2.16}$$

where

X_{11}–X_{18} = variables, as modelled in Equation 2.13

α_{11}–α_{18} = estimated coefficients

u = error term

4. Results and Discussion

4.1. Characteristics of the Cassava Producers

The data in Table 1 describe the characteristics of the cassava producers in Central Madagascar. Among the 240 cassava producing households were 161 sellers (93 off-farm and 68 on-farm), and 79 who do not participate in the market. The empirical results support a generally held belief that transaction costs are a

Table 1. Characteristics of the survey households, by market participation status

Variable description	Seller (participants)		Non-seller (non-participants)	Total
	Off-farm	On-farm		
Number of observations	93	68	79	240
Information and Search Costs Related				
% with membership of a cooperative societies	28.41	17.89	2.66	16.32
% with access to communication facilities	62.14	50.16	13.16	41.82
Education in years	6.72	5.91	6.15	6.26
	(3.35)	(3.12)	(3.28)	(3.25)
Bargaining and negotiation costs related				
% of male respondents	28.16	42.33	61.36	43.95
Age in years	40.11	48.35	49.79	46.05
	(10.31)	(15.12)	(15.19)	(13.54)
% who are native of the community	88.36	83.12	85.35	85.61
Farming experience in years	15.14	10.28	12.71	12.71
	(13.01)	(8.02)	(3.66)	(8.23)
Monitoring and enforcement costs related				
Time to get paid in days	3.10	7.12		5.71
	(2.19)	(5.87)		(4.03)
Number of times payment requested	1.21	5.35		3.28
	(0.64)	(3.66)		(2.15)
% who trust the buyer	52.15	98.67		75.11
Proportional transaction costs related				
% that have personal means of transportation	48.91	15.72	32.75	32.46
Distance from the farm to the market	2.31	9.47		5.89
	(1.11)	(11.99)		(6.55)
Distance to the nearest town (km)	3.74	12.15	8.41	8.10
	(5.81)	(15.71)	(14.34)	(12.62)
Household size	5.12	5.87	6.02	5.67
	(2.02)	(2.05)	(6.25)	(3.44)
Cassava marketing experience in years	10.11	10.35		10.23
	(5.23)	(6.39)		(5.81)
Farm income (Ar)	691,201	352,583		521,892
	(920,001)	(723,805)		(821,903)
% with road connections to the nearest town is good	36.28	39.71	39.24	38.41
Farm size (ha)	0.26	0.49	0.06	0.27
	(0.15)	(0.09)	(0.12)	(0.12)
Yield (t/ha)	2.61	2.93	2.59	2.71
	(1.31)	(1.52)	(2.63)	(1.82)
Quantity sold (t)	1.49	1.87		1.68
	(1.22)	(1.40)		(1.31)
Quantity consumed (t)	0.37	0.90	1.43	0.90
	(0.06)	(0.52)	(0.26)	(0.28)

Note: Field Survey, 2011; numbers in parentheses are standard deviations.

significant deterrent to market participation among agricultural households (Renkow et al., 2004). This, by itself, is not surprising, and can be inferred by simply noting the substantial number of households in the sample that sell cassava at the farm gate (on-farm) rather than sell at the market (off-farm).

Table 1 also reveals the following picture of cassava producing households in the data-set. Majority (62.14%) of off-farm sellers have access to communication facilities, and have about 7 years of formal training, while only 28.41% are members of cooperative societies. The on-farm sellers also have about 6 years of formal training; and 50.16 and 17.89% also have access to communication facilities and are members of cooperative societies, respectively. Among the non-selling households, 2.66 and 13.16% are members of cooperative societies and have access to communication facilities, respectively, and have 6 years of education.

Jensen (2007) noted that prior to the availability of mobile phones, the cost of obtaining information was so high that agents were not able to engage in optimal arbitrage. Alene et al. (2008), studying the maize market in Kenya, found that access to means of communication has a positive but insignificant effect on market participation levels. This, the authors postulated, could be because access to a mobile phone is less useful when accessing market information and in facilitating transactions if there is no viable market information service available, which was the case within the study area. Soysa (2008), in a study on traceability in the agriculture value chain, showed how farmers in Sri Lanka were able to improve their incomes using a simple mobile phone application to reduce waste through a simple feedback system. Here, text messages were sent to the farmers on a daily basis, giving details of the number of rejected products and the reasons why they had been rejected, so they could take immediate, remedial action. The information and search costs for this activity prior to the use of mobile phones had been prohibitively high and had resulted in significant losses, both to the processor and the farmer.

Education also matters in terms of reducing the costs of searching for information, such that the time taken to process and act on information decreases with education level (Pingali, Khwaja, & Meijer, 2005). A higher level of education adds to the intellectual capital stock, which may in turn lead to an increased potential for acquiring skills during work activities (Lapar et al., 2003). Also, a prevalence of social networks and organizations may substantially reduce transaction costs, as often such networks ensure that cooperation takes place among farmers over the use of scarce and communal resources. Moreover, small-scale farmers may be better placed to understand their local environments in a way that ensures the best use of existing resources, and in an environmentally sustainable way (Pingali et al., 2005). Farmers that sell at markets (15.14) and at the farm gate (10.28) tend to be more experienced, implying that they may be better equipped to negotiate (Vakis et al., 2003).

Cassava production in this zone is generally dominated by the use of female labour, except for those farms which do not participate in the market, as these are dominated by men (61.36%). The male farmers (42.33%) are more likely to sell at the farm gate than their female (28.16%) counterparts, who prefer to sell on the market. The transaction costs related to accessing land and credit are much more variable for women than for men (Pingali et al., 2005). All the respondents are still of working age (average 46.05 years) and most (85.61%) are native to their respective communities.

For an average cassava seller who sells on the market, it takes about three days to get paid if he or she sells on credit, and with just one payment request made. However, for those who sell at the farm gate, it takes much longer to get paid (seven days), and such farmers may have to request payment five times. Almost all those who sell at the farm gate (98.67%), and 52.15% of those who sell in the market, noted they trust the buyers, and this may explain why it takes longer time for those who sell at the farm gate to get paid. This may also imply that those who buy at the farm gate tend to be native of their respective communities, or at most from neighbouring communities. Traders are mostly native to the region in which they trade, though family or tribal links between sellers and buyers are most important; for example, a seller will usually operate in his or her own region, due to an affinity with the language and agricultural systems used, as well as with the geography (Minten & Kyle, 1999).

The size of the cassava harvest and farm sizes vary considerably across households. All the respondents have small land holdings (0.27 ha). However, farm gate sellers tend to have more land (0.49 ha) when compared to those who sell in the market (0.26) or those who do not sell at all (0.06). An average off-farm seller produces 2.61 t/ha of cassava, sells 1.49t and consumes 0.06 t, while an average on-farm seller produces 2.93 t/ha of cassava, sells 1.87 t and consumes 0.52 t. On-farm sellers have the most land and may prefer to sell cassava at the farm gate as a result of the huge transaction costs arising from having to transport such a bulky product.

Since most of the households are located in rural areas, the average distance to the nearest town, using a passable road, is 3.74 and 12.15 km for off-farm and on-farm sellers, respectively. On-farm selling households are located on average 9.47 km from the nearest market, when compared to 2.31 km for their off-farm selling counterparts. About 39.24% of the respondents indicated that road conditions in the area are good. This might also partly explain why travel and assembly times during the wet season are longer, and also illustrates the *von* Thunen hypothesis. This says that the more perishable and higher value a product is, the lower distance it will be transported (Minten & Kyle, 1999). However, the main reason for the longer travel times in this case is probably because the roads are often impassable in the wet season.

4.2. Decisions on Market Participation

Table 2 shows the results of the probit regression analysis for market participation levels among the respondents. The goodness-of-fit, measured by the χ^2, showed that the explanatory variables included in the probit model explain quite well variations in decisions made whether to participate in the market or not. The likelihood ratio tests showed that the slope coefficients were significantly different from zero for these participation decisions.

The coefficient for membership of cooperative societies was positive and highly significant at a 1.0% level of probability. Farmers who belong to cooperatives are more likely to participate in the market than their counterparts who do not because the information accessible due to membership of such cooperatives tends to remove the fixed transaction costs faced by smallholder farmers who wish to enter the cassava market. Being a member of an association also allows farmers to gain access to the information needed to increase their returns on crop production and marketing activities, though membership of an association might be viewed as a club good rather than a public good (Boughton et al., 2007).

The gender coefficient was found to be negative and highly significant, at a 1% level. Female-headed households are more likely to participate in cassava markets than the male-headed households, and this is in line with the findings of Arega et al. (2007) who studied maize markets in Kenya and Makhura (2001) in livestock markets in South Africa. Having a female head increases a household's chances of selling its cassava by a greater amount than due to other factors. This implies that women are more inclined to sell their cassava than men, a result in contrast to the expected outcome, but possibly because women are better at bargaining than men. Female farmers also tend to experience lower transaction costs since they tend to have more credibility.

The coefficient for age was found to be negative and significant at a 5% level. This indicates that increasing age leads to a corresponding decrease in the level of participation in cassava markets by farmers, indicating that younger cassava farmers are more likely to participate in cassava markets than their older counterparts. Furthermore, young farmers tend to have stronger social network and have established a good level of credibility within their network (Makhura et al., 2001).

The coefficient for native of community was found to be positive and significant at a 1% level of probability, implying that those native to their communities are more likely to participate in markets.

Table 2. Results of the probit regression analysis for market participation

Variable	Parameter	Coefficient	Std. error	*t*-value
Constant	b_0	2.9115	0.4747	6.1327***
Membership of a cooperative	X_1	0.0382	0.0129	2.9521***
Access to communication facilities	X_2	−0.1252	0.0767	−1.6310
Education level (years)	X_3	−2.9751	5.3974	−0.5512
Gender	X_4	−0.4113	0.1249	−3.2912***
Age (years)	X_5	−0.0813	0.0311	−2.6118**
Native of the community	X_6	0.0742	0.0235	3.1571***
Farming experience (years)	X_7	0.0418	0.0148	2.8113***
Time to getting paid in Days	X_8	−0.0051	0.1188	−0.0429
Number of times payment requested	X_9	0.0037	0.1271	0.0291
Personal means of transportation	X_{10}	0.2715	2.2776	0.1192
Distance to the nearest town (km)	X_{11}	−0.0614	0.0249	−2.4612*
Distance from farm to market (km)	X_{12}	−0.0968	0.0233	−4.1521***
Transportation costs (Ar/t)	X_{13}	−0.0003 .	0.0008	−3.5732***
Condition of road to the nearest town	X_{15}	0.2193	0.0921	2.3811*
Marketing experience (years)	X_{16}	0.0831	0.0683	1.2158
Farm income level (N)	X_{17}	0.000007	0.000004	1.5941
Yield (t/ha)	X_{18}	0.0072	0.0045	1.6027
Log likelihood		−285.5902		
χ^2		0.0000		
Pseudo R^2		0.5190		
Number of observations	240			

*Significant at 10%.
**Significant at 5%.
***Significant at 1%.

This also suggests that fixed costs such as language barriers or discrimination may constrain the ability of non-indigenous or migrant farmers to integrate into some markets (Vakis et al., 2003). It has been found that ethnic similarity reduces barriers to communication and cooperation (Rios et al., Rios, Masters, & Shively, 2008). The coefficient for farming experience was positive and significant at a 1% level of probability, revealing that greater experience (reflecting the ability to negotiate) increases farmers' participation levels.

Among the variables for proportional transportation costs, the coefficient for distance to the nearest town was negative and significant at a 10% level, and distance from the farm to the market and crop transportation costs were also 1% level of probability each. The coefficient for the condition of the road to the nearest town was positive and significant at a 10% level of probability. As a result, farmers who have a long distance to travel to the nearest town, and from the farm to the market, and who have high crop transportation costs, are more un-likely to participate in the market. Some studies have reported that infrastructure such as roads play an influential role in determining market participation levels (Boughton et al., 2007; Goetz, 1992; Heltberg & Tarp, 2002; Key et al., 2000 and Renkow et al., 2004). Poor infrastructure also increases crop transportation costs per km. PTCs also reduce when farmers are located close to markets and have access to a good road network.

4.3. Market Participation Decisions by Seller type (Probit)

The empirical results of the probit regression estimates carried out to establish market participation levels by the type of seller (on-farm or off-farm) are shown in Table 3. The χ^2 was found to be highly significant at a 1% level of probability, indicating a probit regression line of best fit. The likelihood ratio tests indicated that the slope coefficient was significantly different from zero with regard to sellers' decisions on whether to participate in the market or not.

The coefficients for distance to the nearest town and distance from the farm to the market were negative and significant at a 5% level of probability and crop transportation costs at a 1% level of probability. This indicates that the larger the distance to the nearest town, from the farm to the market and from the house to the farm, plus the higher the crop transportation costs, the more likely it is that cassava will be sold at the farm gate (on-farm).

As expected, these results suggest that those households located a long way from the nearest town, and from the market are more likely to sell their cassava in the farm. This seems plausible, since farmers in rural areas do not always have easy access to up-to-date information about markets, for the simple reason that functional extension offices and marketing institutions tend to be located in towns. Also, the greater the distance between the market and the farm, the more likely farmers are to sell at the farm gate, due to the significant transactions costs incurred when travelling long distances to the market along poor roads. Such a scenario also tends to increase crop transportation costs. Binswanger, Khandker, and Rosenzweig (1993) conclude that "the major effect of roads is not via their impact on private agricultural investment but rather on marketing opportunities and reduced transaction costs of all sorts".

The coefficients for personal means of transportation and marketing experience were found to be positive and significant at a 10 and 1% level of probability, respectively. These results imply that having a personal means of transportation and long years of marketing experience increases the probability of a farmer selling cassava at the market. This is expected, since farmers with more marketing experience prefer to take their produce to the market, where they may obtain a better price through bargaining.

4.4. The Level of Off-Farm Cassava Sales

The second stage of the selectivity model (Heckit or OLS accounting for bias) was used to determine those factors influencing the level of off-farm cassava sales (Table 4). The χ^2 value was highly significant at a 1% level of probability indicating goodness of fit of the probit regression line. Also, the inverse mills ratio (lambda) for the level of cassava sales was significant, implying that a sample selection bias would have resulted if the level of off-farm sales had been estimated without taking into account the decision to participate in the cassava market. The Heckman selection model allows us to use information from non-market participants to improve estimates of the parameters generated by the regression model. The Heckman selection model provides consistent, asymptotically efficient estimates for all parameters in the model.

Heckman estimated ρ (rho) as 0.75, the correlation of the residuals in the two equations and sigma (σ = 7.23), the standard error of the residuals of the on-farm equation. In this case, we can reject the null scenario, whereby rho = 0, so we should use a sample selection model for this data. Six of the nine variables had coefficients significantly different from zero in their direct effects, implying that these factors are important in determining cassava sales volumes. The direct and indirect effects are the outcome and selection equations, respectively.

The coefficients for personal means of transportation and road conditions to the nearest town were significant variables, and had a direct relationship with cassava sales, at a 10 and 1% level, respectively. These results suggest that an improvement in personal means of transportation by 1% will lead to an increase of about 0.25, 1.51 and 1.76% in cassava sales, for those who are already selling (on-farm), those participating as off-farm sellers and for all farmers, respectively. A 1% improvement in road conditions to the nearest town; meanwhile, will increase sales by 0.84% for those already selling, 0.13% for off-farm participants and 0.98% for all households. These results might provide a motivation to increase sales through a reduction in variable transaction costs.

Table 3. Results of probit regression for market participation decisions, by seller type

Variable	Parameter	Coefficient	Std. error	*t*-value
Constant	a_0	1.7881	0.1872	9.5543***
Personal means of transportation	a_{10}	0.6211	0.2984	2.0814*
Distance to the nearest town (km)	a_{11}	−0.2172	0.0815	−2.6651**
Distance from farm to market (km)	a_{12}	−0.2913	0.1160	−2.5107**
Transportation costs (Ar/t)	a_{13}	−0.0004	0.0001	−3.1132***
Household size	a_{14}	−0.3471	0.2195	−1.5815
Condition of road to the nearest town	a_{15}	0.0739	0.0734	1.0062
Marketing experience	a_{16}	0.0051	0.0015	3.3571***
Farm income levels (Ar)	a_{17}	5.8152e−05	3.899e−05	1.4914
Yield (t/ha)	a_{18}	0.0013	0.0010	1.2942
Log likelihood		−159.8251		
χ^2		0.0001		
Pseudo R^2		0.4178		
Number of observations	161			

*Significant at 10% level of probability.

**Significant at 5% level of probability.

***Significant at 1% level of probability.

The coefficient for distance to the nearest town was negative and significantly related to the level of sales, at a 10% level of probability. Further, a decrease in distance from the household to the nearest town by a kilometre caused cassava sale levels to increase by 1.15% for those already selling (on-farm), 0.61% for off-farm participants and 1.77% for all households. As such, the location of farmers with respect to potential markets is an important factor in encouraging those farmers to increase their sales (Makhura, 2001). For example, farmers close to urban centres are able to sell much of their cassava since they are relatively close to a range of available and accessible marketing facilities.

The coefficients for distance from the farm to the market were negative and significant at a 5% level of probability for the level of sales, and 1% for all farmers. A 1% decrease in distance from the farm to the market increases off-farm sales by 0.14 and 0.17% for all households. It may be that farmers who have to travel long distances to their farms prefer to increase their off-farm sales before returning home, to decrease the transaction costs associated with travelling. A 1% decrease in crop transportation costs increased sales by 0.007%, participation levels by 0.01 and 0.02% for all households. Increases in variable transaction costs associated with poor infrastructure (mostly road and information) led to increases in crop transportation costs per kilometre.

The coefficient for marketing experience was found to be significant at a 5% level of probability for sales and off-farm participation levels, and at a 1% level for all farmers. This implies that a 1% increase in marketing experience for off-farm cassava sellers leads to a 1.26, 0.71 and 1.98% increase in level of sales, participation levels and among all the households, respectively. This is to be expected, probably because farmers bargain for better prices at the market than when selling at the farm gate.

4.5. Level of On-Farm Cassava Sales

The second stage of the selectivity model (OLS accounting for bias) was estimated to determine those significant factors (variable or proportional transaction costs) influencing level of cassava sales at the farm gate. The results are presented in Table 5. The χ^2 is highly significant at a 1% level of probability. The inverse mills ratio was significant at a 1% level of probability, indicating that a selectivity bias would result if on-farm cassava sales were estimated without taking into account the

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Table 4. Factors influencing Cassava sales levels (off-farm): Heckit results			
Variable	**Direct**	**Indirect**	**Total**
Personal means of transportation	0.2561	1.5135	1.7696
	(2.0143*)	(2.6218**)	(4.6361***)
Distance to the nearest town (km)	−1.1590	−0.6152	−1.7742
	(−1.6571*)	(−2.9173***)	(−4.5744***)
Distance from the farm to the market (km)	−0.1461	−0.0257	−0.1718
	(−2.8214**)	(−1.6072)	(−4.4286***)
Transportation costs (Ar/kg)	−0.0073	−0.0182	−0.0255
	(−2.6181**)	(−2.5029**)	(−5.1210***)
Household size	−0.2614	0.3250	−0.0636
	(−0.0914)	(1.2517)	(−1.1603)
Condition of road to the nearest town	0.8472	0.1371	0.9843
	(3.2715***)	(2.9521***)	(6.2236***)
Marketing experience	1.2692	0.7153	1.9845
	(2.4790**)	(2.5151**)	(4.9941***)
Farm income (Ar)	0.000014	5.1730e−05	0.000019
	(1.0732)	(0.1625)	(1.2357)
Yield (t/ha)	0.0061	−0.00019	0.0059
	(1.1441)	(−1.0027)	(0.4383)
Constant	11.5913	2.6142	14.2037
	(4.5719***)	(2.6731**)	(7.2452***)
P	0.7567		
λ (Mills' ratio)	5.4718 (4.2614***)		
χ^2	0.00001		
Σ	7.2310		
Number of observations	79 (non participants)	172	
	93 (off-farm sellers)		

*Significant at 10% level of probability.
**Significant at 5% level of probability.
***Significant at 1% level of probability.
Figures in parenthesis are *t*-values.

decision to sell cassava. Heckman estimated ρ (rho) as 0.94, the correlation of the residuals in the two equations and sigma (σ = 5.1162), the standard error of the residuals of the on-farm equation. In this case, we can reject the null hypothesis that rho = 0, so indeed we should be using a sample selection model on this data. Three of the eight variables for direct effects had coefficients significantly different from zero.

Distance to the nearest town was positive and significant at a 5% level of probability for both the direct (sales) and indirect effect (on-farm participation), and at a 1% level for all farmers. These results suggest that increased distance to the nearest town increases on-farm cassava sales by 0.71%, participation levels by 0.40% and 1.22% among households participating in the market. Farmers would likely sell more cassava on-farm if the nearest towns were distant, thereby reducing PTCs.

The coefficient for distance from the farm to the market had a positive relationship with cassava sales and was significant at a 5% level of probability. This result suggests that increased distance from the farm to the market increases on-farm sales by 0.61%, participation levels by 0.25 and 0.86% among all households. Farmers who travel long distances from their homes to the market

Table 5. Factors influencing cassava sales (on-farm): Heckit results

Variable	Direct	Indirect	Total
Personal means of transportation	−0.5113	−0.8124	−1.3237
	(−1.2629)	(−0.3172)	(−1.5801)
Distance to the nearest town (km)	0.7177	0.4049	1.1226
	(2.6819**)	(2.4912**)	(5.1731***)
Distance from the farm to the market (km)	0.6113	0.2519	0.8632
	(2.5917**)	(2.6844**)	(5.2761***)
Household size	0.4412	0.1825	0.6237
	(1.0582)	(0.5291)	(1.5873)
Condition of the road to the nearest town	−0.9352	−0.5825	−1.5177
	(−2.9834***)	(−2.6719***)	(−5.6553***)
Marketing experience	1.5319	0.5140	2.0330
	(0.7247)	(0.2018)	(0.9265)
Farm income (Ar)	0.00009	4.912e−05	0.00009
	(1.0051)	(0.6103)	(1.6154)
Yield (t/ha)	0.0082	0.00026	0.0084
	(1.1061)	(0.2967)	(1.4028)
Constant	15.8143	−6.9731	8.8412
	(5.1826***)	(−3.7253***)	(1.4573)
P	0.9424		
λ (Mills' ratio)	4.8217		
	(3.5114***)		
χ^2	0.00001		
Σ	5.1162		
Number of observations	79 (non participants)	147	
	68 (On-farm sellers)		

*Significant at 10% level of probability.
**Significant at 5% level of probability.
***Significant at 1% level of probability.
Figures in parenthesis are *t*-values.

incur significant transaction costs, and so may decide to sell more at the farm gate in other to mitigate these costs.

The condition of the road to the nearest town was negatively signed and significant at a 1% level of probability. This result suggests that poor road conditions result in a decrease in the level of on-farm cassava sales by 0.93%, as well as a 0.58% decrease in participation levels and 1.51% among all households. Farmers may; therefore, decide to sell more cassava off-farm if road conditions are good.

5. Conclusion

Smallholder cassava farming in central Madagascar is characterized by low levels of market participation. These results support previous studies which have found that the existence of transaction costs constrains households in terms of their selling activities. Collectively, these results demonstrate the importance of allowing for non-negligible fixed costs when carrying out market participation studies. When these costs are ignored and turn out to be non-negligible, a significant bias appears in the participation and sales estimations. Policies that reduce transaction costs through improved transportation and the promotion of marketing organizations would increase output; by both increasing market participation and production levels among market participants. In addition, improving rural infrastructure (e.g. access roads) would facilitate the faster delivery of farm produce (especially perishable commodities such as cassava) to urban consumers. Another critical step in generating more marketable surplus would be to facilitate the private sector provision of market information via improved telecommunications. In summary, the transaction costs incurred through

participation and sales could be reduced through the existence of improved information and transportation infrastructure, by the deeper penetration of reputable input distributors, and also the promotion of institutional innovations such as production and marketing cooperatives.

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