

ANALYZING SMALLHOLDERS' AGRICULTURAL COMMERCIALIZATION IN BURKINA FASO: THE ROLE OF TRANSACTION COSTS AND HOUSEHOLDS' ASSETS

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ABSTRACT

Promoting smallholders' agricultural commercialization is frequently identified as a promising strategy to improve agricultural contribution to poverty reduction and economic growth in developing countries. This paper analyses the determinants of agricultural commercialization of smallholder farmers in Burkina Faso, focusing on the role of transaction costs and households' productive resources. Based on data collected in 2011 at national level from a sample of 1178 farm households, a double hurdle model of market participation and intensity of participation measured by crop commercialization index is estimated. The results indicate that households' productive resources such as farm size per worker, use of animal traction, quantity of fertilizer used per hectare and access to credit significantly increase the likelihood of households' market participation and the intensity of commercialization. In addition, transaction costs factors such as quality of rural roads and ownership of communication assets have positive and significant effects on the probability of market participation. Therefore, reducing remoteness-induced transaction costs by unlocking rural areas and improving farm households' access to productive assets and technologies are required to promote agricultural transformation and commercialization of smallholder farmers.

Keywords: Agricultural Commercialization, Transaction Costs, Assets, Burkina Faso

JEL: Q12, Q13, O12

INTRODUCTION

Integrating smallholders' agriculture into market economy is urgently required to improve agriculture's contribution to poverty reduction and economic growth in developing countries. Indeed, subsistence farming entails inefficiency and is argued to not be viable to ensure sustainable access to food in the long run (Pingali, Khwaja, & Meijer, 2005; Pingali, 1997; Pingali & Rosegrant, 1995). However, despite various agricultural policy reforms in Africa, the majority of farmers are still subsistence-oriented with low level of participation in agricultural markets. Moreover, the quantities sold by most farmers are generally limited. For instance, Jayne et al. (2010) estimated about 20% to 35% the proportion of smallholders that sell crops in a given year in Sub-Saharan Africa and found a high concentration of marketed agricultural surplus among a small number of farm households that have relatively large land size.

The low supply response of farm households to policy incentives is frequently related to high level of transaction costs in agricultural sector (Barrett, 2008; Goetz, 1992; Key, Sadoulet, & De Janvry, 2000). In fact, estimating a Heckman switching regression model of market participation and quantity of trade in Senegal grain market, Goetz (1992) showed that fixed transaction costs represent a key barrier of smallholder farmers' market

participation while better access to information improves their participation. In addition, transaction costs tend to be higher for farmers living in remote areas with poor communication and transportation infrastructure. Renkow et al. (2004) found that the level of transaction costs faced by Kenyan smallholder maize farmers is equivalent to an ad valorem tax of 15% which increases with the level of economic isolation of rural areas. In Latin-America, Vakis et al. (2003) found that the information on market price that farmers receive from their neighbours reduces fixed transaction costs by the equivalent of doubling the price received, and was equal to four times the average transportation costs. Escobal (2001) estimated the transaction costs at 50% to 60% of sale value for farmers who are connected to market without a motorized track in Peru with smallholders facing the higher transaction costs (estimated at 67% of sale value) than the large farmers (32%).

Though improving physical market access and reducing transaction costs have important implications in farm households' market participation, supply response may still remain low in the absence of adequate access to productive resources to produce a marketable surplus. Using a double hurdle model, Olwande et al. (2015) showed the importance of access to productive assets and technology use in improving smallholders' participation in agricultural markets in Kenya. Fafchamps & Hill

(2005) showed that when the quantity to be sold are large and/or market is close, coffee farmers in Uganda, particularly better-off farmers, are more likely to sell in the market where they can get better price. **Boughton et al. (2007)** in a study on Mozambique farm households' supply showed that private assets, especially land, livestock, labour and equipment have significant effects on the likelihood of farm households' participation in crop markets and the earnings are positively correlated with quantity of land holding. **Barrett (2008)** argued that the likelihood of farm households to be gross buyers in the market is high among those with smaller land size. However, this probability reduces steadily with the increase in household's land holdings.

Thus, these previous studies reveal that differences in access to productive resources as well as the level of transaction costs faced by farmers explain the differences in market participation. Yet, the importance of each factor in explaining the heterogeneity of farm households' participation in agricultural commercialization may differ across households and countries, requiring in each case, a deep investigation into the drivers of smallholder farmers' marketing behaviour. However, existing empirical studies scarcely highlight at the same time the effects of both the role of farm households' productive assets and the level of transaction costs on the level of crop supply. In addition, there is a dearth of empirical researches on the drivers of agricultural commercialization in Burkina Faso, despite the increase interest in recent years to promote commercial farming in the country. Therefore, the objective of this paper is to analyse the determinants of smallholders' agricultural commercialization in Burkina Faso focusing on both transaction costs factors and the level of household asset endowment. Specifically, the study identifies the effects of transaction costs factors and households' productive assets on market participation decision and the level of agricultural commercialization.

MATERIALS AND METHODS

Theoretical framework of farm households' marketing behaviour

This theoretical framework is a farm household model in which transaction costs and productive resources affect households' marketing behaviour. Based on **Barrett (2008)**, the general feature is that a farmer chooses to participate in the market of each crop c as seller, buyer or remains autarkic depending on the costs of market access. Thus, let M_{cs} be a binary variable of market participation as seller whose element takes the value 1 if the household participates in the market of crop c as seller, and 0 otherwise. Similarly, let M_{cb} represents the buyer's side of market participation taking the value 1 for each crop the household buys and 0 if not. For each crop c , let $f_c(.)$ and Q_c represent respectively the production function and the quantity consumed by the household. Thus, the net sale can be expressed as:

$$NS_c = f_c(A_c, I_c, G) - Q_c \quad (1)$$

NS_c is positive if and only if $M_{cs} = 1$ and negative if and

only if $M_{cb} = 1$. A_c , I_c and G represent respectively the level of household assets and inputs allocated to the production of crop c and the availability of public goods. This formulation (Eq. 1) deals with a static problem of farm household marketing behaviour. Thus, by considering the net sale of farmer, it is assumed that a given household is either seller or buyer such that the equation $M_{cs} * M_{cb} = 0$ always holds.

The problem of the household is to make market participation decision and the level of production of crops in order to maximize the utility $U(.)$ over the consumption of a set of goods produced (Q_c) and bought from the market (x). So, the optimization problem of the household choice can be formulated as follows:

$$\max_{M_{cs}, M_{cb}, Q_c, x, A_c} U(Q_c, x) \quad (2)$$

Subject to

$$\sum_{c=1}^C M_{cb} P_c^* Q_c + P_x x = \sum_{c=1}^C M_{cs} P_c^* f_c(A_c, I_c, G) + Y \quad (3)$$

Cash constraint

$$A = \sum_{c=1}^C A_c \quad (4)$$

Constraints of productive resources (e.g. labour and land)

$$f_c(A_c, I_c, G) \geq Q_c(1 - M_{cb}) \quad \forall c = 1, \dots, C \quad (5)$$

Constraint of market participation

$$NS_c = f_c(A_c, I_c, G) - Q_c \quad (6)$$

Market supply

Where:

P_c^* represents the price effectively received by seller or paid by buyer of crop c and P_x the market price of other tradable goods x . The left-hand side of the budget constraints (Eq. 3) represents households expenditure on agricultural crops ($\sum_{c=1}^C M_{cb} P_c^* Q_c$) and on other tradable goods ($P_x x$) while the right hand-side denotes farm income ($\sum_{c=1}^C M_{cs} P_c^* f_c(A_c, I_c, G)$) and off-farm income (Y). The third constraint (Eq. 5) states that for a household to be self-sufficient or seller of a given crop c (i.e. $M_{cb} = 0$), the production level must be at least equal to the consumption level. In fact, if the production is equal to the quantity consumed by the household, the net sale is zero. Conversely, if production is greater than quantity consumed, the net sale is positive. Furthermore, the buyer household ($M_{cb} = 1$) may also be a producer or not of the crop. Solving this model gives for each feasible combination of M_{cs} and M_{cb} , the optimal choice of vector of quantity consumed (and that supplied) of agricultural commodities and of other tradable goods, and the optimal allocation of private assets for production $\{Q_c, x, A_c\}$ and then the market participation decision that maximizes farmer utility function (**Barrett, 2008**).

However, a household that participates in the market faces the market price P_{cm} for each crop c and the level of transaction costs $\tau(Z, A, G, Y, NS_c)$. Thus, the price of each crop that farmers effectively receive or pay is household-

specific and can be expressed according to the position of each household in the market as follows:

$$\begin{cases} P_c^* = P_{cm} + \tau_c(Z, A, G, Y, NS) \\ \text{if } M_{cb} = 1, \text{ i.e. household is net buyer of crop } c \\ P_c^* = P_{cm} - \tau_c(Z, A, G, Y, NS) \\ \text{if } M_{cs} = 1, \text{ i.e. household is net seller of crop } c \\ P_c^* = P_a \text{ if } M_{cb} = M_{cs} = 0, \\ \text{if i.e. household is autarkic for crop } c \end{cases}$$

P_{cm} is the price of crop c in the local market, P_a is the autarkic shadow price that exactly equates household demand and supply. Z represents households characteristics which may include gender, age, education level of household head, etc. Therefore, the household demand and supply functions that maximize the utility depend on the market price (which include the transaction costs) and a set of household assets and can be respectively expressed as:

$$S = S(P, A) \quad (7)$$

$$D = D(P, A) \quad (8)$$

These functions can be graphically represented to show how differences in households' productive resources and the level of transaction costs explain market participation and intensity of commercialization (Figure 1). The presence of transaction costs τ in output market renders market participation not profitable for farmers within the price band between $P_{cm} - \tau_c(\cdot)$ and $P_{cm} + \tau_c(\cdot)$. In this case, the optimal solution is for the household to produce just for internal consumption. This means that within this price band, household supply is inelastic to market price, unless price change is sufficiently high to at least cover the transaction costs of market participation. This is the case for instance of household 2 with a supply function $S_2(P, A_{2c})$ where the internal equilibrium defines the shadow price at P^* . This shadow price which is specific to

each household is explained by the difference in household resource endowment and the level of transaction costs. However, for the household with the supply function $S_3(P, A_{3c})$, the internal equilibrium is established below the price band. Thus, by participating in the market as sellers, this household would effectively receive the price $p_c = p_{cm} - \tau(\cdot)$ which is still greater than its internal shadow price.

Empirical methods: The double hurdle model (DHM)

The challenge of estimating the determinants of agricultural commercialization of farm households resides in the fact that numerous households live entirely on subsistence farming system and do not report a positive amount of output sale which may cause a selection problem in the estimation procedure. Therefore, in order to estimate unbiased parameters, an empirical model such as the Heckman, Tobit or double hurdle that deals with this issue is required. However, the Heckman approach is more suitable for incidental truncation where the zeros represent unobserved values, such as in the case of wage rate models where the sample includes unemployed persons (Cameron & Trivedi, 2005; Heckman, 1979). This means that the use of Heckman regression in the case of agricultural market participation implicitly assumes that the zero observations are the consequence of prohibitive transaction costs that prevent households from engaging in commercial farming (Alene et al., 2008). Several empirical findings supported this view that high transaction costs in rural markets represent a key barrier to market participation. However, in the context of subsistence farming, the choice of households not to participate in the markets may also be due to the lack of marketable surplus which may be seen as a rational choice.

Therefore, to take into account both transaction costs and low agricultural surplus as potential explanations of agricultural commercialization of smallholders, a corner solution model such as Tobit or double hurdle model would be appropriate.

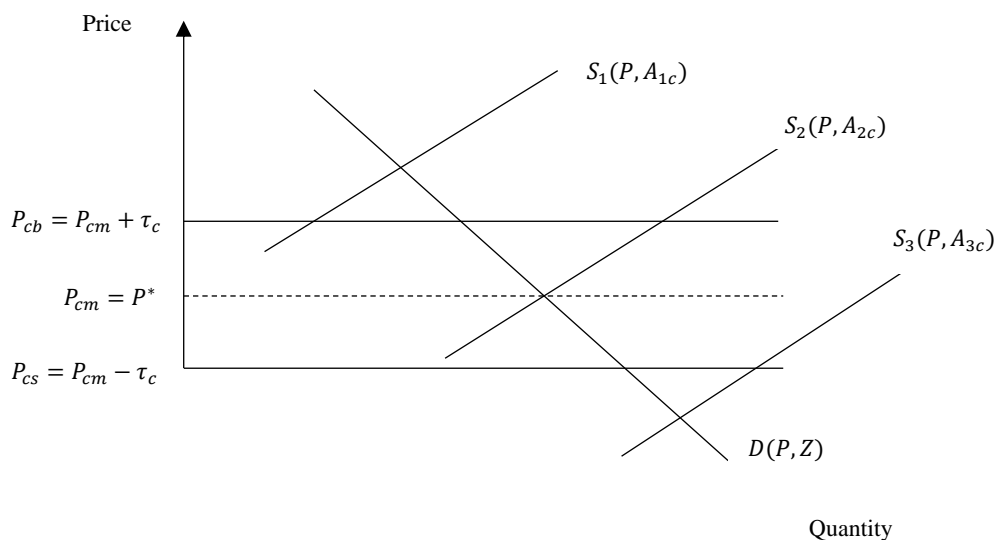


Figure 1: Farm household output demand and supply in the presence of transaction costs
Source: De Janvry & Sadoulet (1993)

The double hurdle model (DHM) is originally proposed by **Cragg (1971)**. This model is a corner solution outcome like Tobit. However, the DHM is more flexible and represents a generalization of Tobit Model. In fact, contrary to Tobit model, the double-hurdle approach does not require the assumption that the participation and the intensity of participation be determined by the same process (**Burke, Myers, & Jayne, 2015**). It therefore provides a useful framework to examine separately the effects of variables on the probability of participation in crop markets and the intensity of sale. The model considers that each household has to overcome two hurdles in the marketing decision making process and specifies for each step of decision the corresponding equation. The first equation specifies the decision to participate or not in the agricultural markets while the second one refers to the equation of the intensity of sale. Thus, a household decision to participate in crop market and quantity traded can be written as follows:

Decision equation:

$$d_i^* = z_i\delta + \mu_i \quad (9)$$

Where d_i^* is a latent variable indicator of household market participation and $\mu_i \sim N(0, 1)$

$$d_i = \begin{cases} 1 & \text{if } d_i^* > 0 \\ 0 & \text{if } d_i^* \leq 0 \end{cases} \quad (10)$$

$d_i = 1$ if the household i effectively participates in the market of crops as sellers (i.e. $d_i^* > 0$) and $d_i = 0$ if household i does not sell in the market ($d_i^* \leq 0$). Conditional to market participation decision (Eq. 10), the intensity of sale by a given household can be expressed as follows:

$$y_i^* = x_i\beta + \varepsilon_i \quad (11)$$

With $\varepsilon_i \sim N(0, \sigma^2)$

Where z_i and x_i are vectors of observed variables that explain respectively households' decision to participate in the market and the intensity of sale. δ and β are vectors of parameters to be estimated; μ_i and ε_i are the error terms. In this model, the positive quantity sold is observed only if household participates in crop market and zero if otherwise. Hence, the observed quantity sold (y_i) related to latent sale y_i^* is:

$$y_i = \begin{cases} y_i^* & \text{if } d_i = 1 \text{ and } y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (12)$$

The original specification of the model of **Cragg (1971)** assumed independence between the error terms of the two hurdles. If the error terms μ_i and ε_i are normally, independently and identically distributed, that is,

$$\begin{pmatrix} \mu_i \\ \varepsilon_i \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix} \right] \quad (13)$$

then, the maximum likelihood estimator can be obtained by Probit regression for the first step of the model (Eq. 9

and Eq. 10) and truncated normal regression for the second step (Eq. 11 and Eq. 12). The likelihood function of the DHM under the assumption of independence of error terms can be expressed as follows (**Cragg, 1971**):

$$L(d, y|x, z) = [1 - \Phi(z\delta)]^{1(d=0)} \left[\Phi(z\delta)(2\pi)^{-\frac{1}{2}}(\sigma^{-1}) \exp \left\{ -\frac{(y-x\beta)^2}{2\sigma^2} \right\} / \Phi\left(\frac{x\beta}{\sigma}\right) \right]^{1(d=1)} \quad (14)$$

This study follows the estimation procedure described by **Burke (2009)** to jointly estimate the first and second stages of the model. In addition, for each explanatory variables, the unconditional Average Partial Effects (APEs) are computed. Finally, the standard errors of the APEs are estimated by bootstrapping with 100 replications.

Measuring the level of farm households' agricultural commercialization

Let y_i represent the intensity of household participation in agricultural output markets (or agricultural commercialization). The most frequently used method of measuring agricultural commercialization in the literature is the proportion of value of crop sold with respect to the value of crop harvested (**Govereih & Jayne 2003; Govereih et al. 1999; Ochieng et al. 2016; Rios et al. 2009; Von Braun 1995**). This index, referred to as Household Crop Commercialization Index (CCI) can be expressed as follow:

$$CCI_i = \left(\frac{\sum_{k=1}^K P_k S_{ki}}{\sum_{k=1}^K P_k Q_{ki}} \right) * 100 \quad (15)$$

Where P_k denotes the market price of the crop k . S_{ki} and Q_{ki} represent respectively the quantity sold and harvested of crop k by household i . This index attempts to measure the degree of households' market participation in a scale neutral manner independently of households' wealth and productivity. The advantage of using these approaches is also that it avoids the crude distinctions between subsistence and commercial farm households. Thus, the commercialization index can take any value from zero which means total subsistence-oriented production (no crop sold) to hundred (all crops produced are sold).

The study focuses on rain-fed crop commercialization. Therefore, livestock and non-rain fed crops such as vegetables and fruits are not included in the computation of commercialization index. The model is estimated using two different commercialization indexes: Household commercialization index of food crops and Commercialization Index of overall agricultural output. The former concerns the main food crops produced and consumed in Burkina Faso that are sorghum, millet and maize while the latter focuses on all agricultural crops produced that encompass cereals and traditional cash crops.

Definition of explanatory variables

The explanatory variables in the model include transaction costs' variables, household productive assets and household characteristics. Transaction costs variables include ownership of communication equipment which is used to capture household access to information while the quality of rural roads, the distance to market as well as ownership of transportation assets reflect transportation conditions. Household productive resources are captured in the model by farm size per adult, use of animal traction, access to credit and the amount of fertiliser used per hectare. In addition, household socio economic characteristics such as age, gender, education level of household head and household dependency ratio as well as participation in non-farm activity are included. The definition and expected signs of the variables used are presented in Table 1.

Data source and descriptive statistics

Data used in this study come from a survey undertaken in 2011 in rural Burkina Faso by the department of economics of University Ouaga II on a sample of 1178 farm households selected across the entire country. Two-stages and randomized sampling approaches was used to select the sample. In the first stage, villages was selected across the 13 regions according to the representativeness of each regions in the country making a total of 270 villages. Within each village, households was stratified according to their ownership and use of animal traction and randomly selected within each stratum. Finally, the

total sample size retained was 1178 households which is distributed across 270 villages of the 13 regions of the country. Details on the sampling procedure can also be found in **Porgo, Kuwornu, Egyir, Zahonogo, & Jatoo (2018)**.

The statistics show that about 45% of farmers did not sell any crop and 28% of farmers sold less than 25% of their outputs. Furthermore, 14% of farmers present a crop commercialization index that is between 25 to 50% while only 12% sold at least 50% of their crops (Table 2).

In addition, the statistics show that roughly 17% of total farm output produced is sold and 55% of farm households participate in agricultural output markets as sellers (Table 3). Among farmers that sold crops, the quantity brought to market represents on average 30% of their production. Considering the specific case of staple food crops (maize sorghum and millet), about 24% of households participate in the market by selling 22% of their produce. Thus, this confirms the fact that not only a huge number of farm households are working on full subsistence basis, but also among the market participants, market supply of many households is still rather low. Similar results are found in numerous Sub-Saharan Africa countries. Indeed, **Gebremedhin & Jaleta (2010)** estimated at about 25% the proportion of crop sold by Ethiopian farm households. **Carletto et al. (2017)** estimated the level of crop commercialization index at 17.6% in Malawi, 27.5% in Tanzania and 26.3% in Uganda.

Table 1 Definition of explanatory variables and expected signs

Household characteristics	Measurement	Expected signs	
		Equation of Participation	Intensity of sale
Gender of household head	Binary (1 if man)	+/-	+/-
Education of household head	Number of years of formal education	+	+
Age of household head	Number of years	+/-	+/-
Dependency ratio	Dependents/active members	-	-
Use of animal traction	Binary (1=yes)	+	+
Livestock ownership	TLU	+	+
Farm size per adult	Hectare	+	+
Distance to nearest market	Kilometer	-	-
Quality of rural roads	Binary (1 if all-weather road links the village to nearest city)	+	+
Nonfarm activities	Binary (1 if household head is engaged in nonfarm activities)	-/+	+/-
Average Cereal price	CFA/kg	+	+
Access to credit	Binary (1 if household head has access to credit)	+	+
Fertilizer used per ha of land	Kilogram	+	+
Ownership of transportation equipment	Binary (1 if the household owns motorbike or car)	+	+
Ownership of radio/TV/phone	Binary (1 if the household owns phone/radio or TV)	+	+
Agro-climatic zone	Binary (1=South-Sudan zone)	+/-	+/-

Table 2 Proportion of market participants in the sample

Crop Commercialization Index	Observations	% in the sample
No quantity sold (0%)	523	44.40
Less than 25% (< 25%)	340	28.86
From 25 to less than 50% (<=25 ;< 50%)	165	14.01
50% and Above (>= 50 %)	150	12.73
Total sample	1,178	100

Table 3 Crop Commercialization Index (CCI) among Producers and Sellers

Crops	Producers			Sellers		
	Observations	% in the sample	Mean of CCI	Observations	% in the sample	Mean of CCI
Maize	492	41.8	6.54	86	7.30	37.4
Sorghum	1,024	86.9	5.74	185	15.7	31.8
Millet	536	45.5	3.34	69	5.86	26.0
<i>Staple Food</i>	<i>1,178</i>	<i>100</i>	<i>5.19</i>	<i>282</i>	<i>24</i>	<i>21.68</i>
Cotton	151	12.8	99.7	151	12.8	99.7
Rice	161	13.7	28.5	76	6.45	60.4
Groundnut	521	44.2	359.9	286	24.3	655
Peanut	414	35.1	17.2	138	11.7	51.6
Voandzou	89	7.56	21.8	23	1.95	84.5
Sesame	94	7.98	67.7	69	5.86	92.3
<i>All sample</i>	<i>1,178</i>	<i>100</i>	<i>16.97</i>	<i>655</i>	<i>55.60</i>	<i>30.52</i>

RESULTS AND DISCUSSION

Factors affecting market participation decision of smallholders and intensity of crop commercialization

The estimation results of double hurdle model of determinants of smallholders' agricultural commercialization in Burkina Faso are reported (Table 4). Considering the Probit regression in the first stage of the model (Hurdle 1), the likelihood of farm households' participation in crop markets is positively and significantly affected by farm size per adult (in both regressions). This result supports the point of **Barrett (2008)** that, the probability of becoming a crop seller increases when land holding increases. Similarly, **Heltberg & Tarp (2002)** in the case of Mozambique and **Olwande et al. (2015)** in the case of Kenya found a positive and significant effect of farm size on households' market supply. In Burkina Faso, it is commonly argued that production growth is more driven by increase in farm size than improvement in farm productivity (**Kaminski, 2011**). This may also explain the central role of farm size on the probability of farm households' decision to participate in the market as sellers of crops.

In addition, adoption of mechanized system (use of animal traction) increases the probability of farm households' participation in crop market as sellers in both regressions. In addition, at 1% significance level, the use of modern input namely fertilizer increases the probability of being seller of crops. This suggests that households' decision to sell crops is closely linked to their access to productive resource and inputs. Indeed, access to these resources increases farmers' ability to produce a marketable surplus and then their likelihood to participate in the market. These findings confirm the studies that highlight the importance of productive resources on smallholders' crop supply in African countries (**Alene et al., 2008; Boughton et al., 2007; Olwande et al., 2015**).

Household ownership of transportation assets (motorbike or bicycle) and communication assets (radio, phone or TV), used as proxies of transportation and information facilities, show no significant effects on the probability of farm households' participation in food crop market. This is contrary to our expectations and to some empirical studies which suggest that the use of radio or phone may

reduce information asymmetry, reduce price dispersion and then stimulate market participation (**Aker, 2010; Courtois & Subervie, 2015**). However, some studies also found that the effect of access to information on agricultural commercialization is more important for perishable crops than for traditional staple crops (**Fafchamps & Minten, 2012; Muto & Yamano, 2009**). The absence of significant effect in this case may also be due to the fact that these communication equipment do not represent the main channel through which market information concerning food crops is provided and that households may instead, have more preference for information received from neighbours as found by **Vakis et al. (2003)**.

However, considering all the crops, ownership of communication equipment has a positive and significant effect on the likelihood of market participation. Though, it does not induce a significant increase in the likelihood of participation in food crop market, having communication equipment (phone, radio or TV) increases the probability of farm households to participate in agricultural output market as sellers by reducing the costs of access to market information. Existence of all-weather roads which is also used as an indicators of transaction costs increases significantly the probability of households' participation in agricultural markets. This is consistent with the empirical findings that, rural isolation increases transaction costs and negatively affects households' market participation (**Renkow et al., 2004**). In addition, transportation costs which increase in absence of good quality of roads may affect households' cropping pattern toward subsistence farming and reduce their market supply (**Key et al., 2000; Omamo, 1998**).

Furthermore, the results show that households that have access to credit are more likely to participate in markets. However, if the head of the household is engaged in nonfarm activities, the likelihood of the household selling food crop falls. This effect may be explained by the fact that access to non-farm activities, which represents an opportunity for income earning, modifies the livelihood strategy of the farm households by reducing their reliance on food crop sale. This results in a reduction of their reliance on farm income and lowers their incentive to

engage in commercial farming, particularly as far as food crops are concerned.

The results of the second stage of the model describing the determinants of conditional market participation reported in the second column (Hurdle 2) indicate that at 5% level of significance, distance to nearest market is negatively correlated with the intensity of food crop sale (Table 4). This means that once farm households decide to sell food crops, the intensity of sale falls as the distance that separates them from the market increases. Concerning the overall crop commercialization, the results indicate significant effects of households' productive resources and access to inputs on the conditional intensity of sale (i.e. intensity of participation

in crop markets, once market participation decision is made). Furthermore, conditional on market participation, the effect of credit access on the intensity of crop sale is still positive and statistically significant while engaging in nonfarm activity reduces the intensity of crop sale among market participants. Although, ownership of communication equipment by the household head increases the probability of participation in the crop market (Hurdle 1), once participation decision is taken, this factor no longer determines the intensity of sale. This suggests that costs related to information access may be treated as fixed transaction costs which do not affect the intensity of sale (Key et al., 2000).

Table 4 Results of double hurdle model of determinants of smallholders' agricultural commercialization

Variables	Hurdle 1		Hurdle 2	
	Probit estimator of Participating in crops market		Truncated normal estimator of intensity of crop sale upon participation	
	Food crops	All crops	Food crops	All crops
Farm size per adult (ha)	0.525*** (0.080)	0.566*** (0.077)	5.302 (3.783)	8.205*** (2.649)
Livestock (TLU)	-0.011 (0.013)	0.013 (0.012)	1.136* (0.603)	-0.024 (0.400)
Fertilizer use per ha (kg)	0.003*** (0.001)	0.005*** (0.001)	0.029 (0.037)	0.209*** (0.032)
Use traction (1=yes)	0.303*** (0.094)	0.211** (0.084)	0.943 (4.778)	3.591 (3.107)
Credit access (1=yes)	0.275*** (0.092)	0.509*** (0.090)	0.744 (4.295)	18.895*** (2.994)
Nonfarm activity (1=yes)	-0.200** (0.087)	-0.087 (0.080)	2.587 (4.037)	-8.594*** (2.790)
All weather roads (1=yes)	0.094 (0.093)	0.280*** (0.088)	5.313 (4.208)	1.598 (2.837)
Distance to nearest market (km)	0.007 (0.007)	0.009 (0.007)	-0.765** (0.302)	0.232 (0.188)
Transportation equipment (1=yes)	-0.039 (0.100)	-0.079 (0.093)	4.427 (4.394)	1.494 (3.109)
Communication equipment (1=yes)	-0.015 (0.122)	0.218** (0.110)	3.950 (6.366)	5.541 (4.417)
Gender (1=man)	-0.203 (0.220)	-0.074 (0.194)	-17.905* (10.271)	-8.318 (8.359)
Age of Household Head (HH)	-0.004 (0.003)	-0.002 (0.003)	-0.122 (0.155)	-0.180* (0.106)
Education level of HH (year)	0.026 (0.021)	0.020 (0.021)	0.948 (0.852)	1.325** (0.602)
Dependency ratio	-0.130** (0.055)	-0.052 (0.050)	0.427 (2.614)	-5.499*** (1.867)
Village level cereal price (CFA/kg)	0.0003 (0.002)	-0.003 (0.002)	0.158 (0.107)	-0.062 (0.077)
South-Sudan zone (1=yes)	0.254*** (0.091)	0.104 (0.087)	14.481*** (4.430)	11.560*** (2.950)
Constant	-1.169*** (0.443)	-0.563 (0.407)	-12.517 (21.569)	19.324 (15.239)
Log likelihood		-1694.46		-3464.17
Wald chi2(16)		123.51		163.66
Prob>chi2		0.000		0.000
Observations		1,178		1,178
Sigma		21.937*** (2.034)		25.352*** (1.282)

Note: (*), (**) and (***) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively. Standard errors are in parentheses for the DHM and bootstrap standard errors for the APEs

Table 5 Average partial effects unconditional to participation decision

Variables	Food crops		All crops	
	Coefficients	Std. Err	Coefficients	Std. Err
Farm size per adult	3.600***	0.659	7.515***	1.106
Livestock (TLU)	0.061	0.095	0.108	0.171
Fertilizer use per ha	0.022*	0.0125	0.108*	0.063
Use traction	1.843**	0.798	2.96**	1.398
Credit access	1.660**	0.696	10.261***	1.115
Nonfarm activity	-0.860	0.681	-3.392***	1.179
All weather roads	1.125	0.750	2.965**	1.158
Distance to nearest market	-0.042	0.051	0.150	0.085
Own transportation equipment	0.266	0.710	-0.245	1.294
Own communication equipment	0.353	1.057	3.618**	1.593
Gender	-3.141	1.93	-3.192	3.094
Age of Household Head (HH)	-0.035	0.025	-0.074**	0.035
Education level of HH	0.254	0.183	0.580**	0.260
Dependency ratio	-0.701*	0.385	-2.132***	0.711
Cereal price in the village	0.019	0.0210	-0.041	0.031
South-Sudan zone (1=yes)	3.058***	0.72	4.438***	1.442

Note: (*), (**) and (***) indicate the levels of significance of the corresponding coefficients at 10%, 5% and 1% respectively. Standard errors are obtained by bootstrapping with 100 replications.

Other factors such as age of household head and dependency ratio negatively affect the level of crop sale. Thus, the larger the number of inactive members in the household relative to the active members, the lower would be the intensity of crop commercialization among farm households. In addition, climate condition represents a key determinant in households' decision to participate in crop markets and in the intensity of commercialization in both regressions. Thus, farm households located in the South-Sudan climatic zone, which is the most suitable zone for agricultural activities in Burkina Faso, are not only more likely to participate in crop market as sellers, but also present significantly higher intensity of sale among crop sellers than those located in the Sahel-Sudan and Sahel climate zones.

Average partial effects (APEs)

The average partial effects (i.e. the unconditional marginal effects) assess the effects of regressors on the intensity of crop sale regardless of farm households' marketing position (Table 5). The findings show again the importance of access to productive resources such as farm size, use of animal traction, access to credit and quantity of fertilizer use per hectare on the unconditional level of crop commercialization. Indeed, an increase in average farm size per adult by one hectare results in 3.6 points increase in the intensity of commercialization of food crops while an increase in fertilizer use per hectare by 10 kilograms leads to increase in the intensity of food crop sale by 0.22 units for the overall sample.

Concerning the second regression of all crop sale, the average Partial Effects of farm size and fertilizer use are higher (7.5 and 0.10 respectively). In addition, credit access and use of animal traction improve the overall intensity of sale. Thus, adoption of mechanized agricultural system such as use of animal traction increases the degree of commercialization of crop output by about 3 units compared to non-adopters. Furthermore, the average partial effect of access to credit is 10,

significant at 1%. This means that households that have access to credit, are about 10 units more commercial than those who do not have access to credit. These findings suggest that limited production capability represents a major cause of low intensity of market participation by farm households in output market.

However, none of the proxies of transaction costs show a strong and significant average partial effect (APE) on the level of food crop sale, indicating that access to productive resources represents the key factors explaining the intensity of smallholders' food crop supply in Burkina Faso. However, considering the overall crop commercialization index, all the variables of transaction costs factors have significant average partial effects (APE) on the intensity of crop sale with the expected signs, except the ownership of transportation equipment. Indeed, the quality of rural roads has positive and significant effect on the level of crop commercialization. Households located in accessible areas are 3 units more commercial than the others. In addition, the APE of ownership of communication equipment of 3.5 means that households that own some communication assets would be 3.5 units more commercial than farmers that do not use any communication equipment. These findings suggest that reducing transaction costs through improving rural accessibility and access to information can play a crucial role in commercial orientation of smallholders and their overall market supply.

CONCLUSIONS AND RECOMMENDATIONS

Numerous factors have been identified as having important effects on farm household's market supply in developing countries. The most important include the level of transaction costs and households access to productive resources and improved technologies. Thus, using a double hurdle model, the influence of these factors on smallholders' market participation and intensity of commercialization in Burkina Faso is analysed.

This paper finds that access to productive technology and resources such as adoption of mechanized system (use of animal traction), the quantity of fertilizer used per hectare, access to credit and farm size per adult as well as transaction costs factors such as ownership of communication equipment and existence of all-weather roads increase significantly the likelihood of farm households' market participation when commercialization index of overall crop produced is considered. Yet, conditional to market participation, factors of transaction costs do not show strong influence on the intensity of sale. Thus, these factors may be seen as indicators of fixed costs which influence only the first decision to sell but not necessarily the intensity of sale. Furthermore, the average partial effects of these factors of productive resources and transaction costs factors on the intensity of crop sale are statistically significant. This means that the probability of participating in agricultural markets as sellers and the overall intensity of sale are positively explained by both access to productive resources and factors reducing transaction costs. However, considering the specific case of food crop commercialization, the results indicate that access to productive resources represents the key drivers of farm households' food crop supply.

Therefore, for households to profitably benefit from market participation and increase their market supply, there is a need for reducing remoteness-induced transaction costs in the agricultural sector. Therefore, policymakers should give special attention in unlocking rural areas by improving the quality of road infrastructure and farm households' access to market information. In addition, the results indicate that improving rural access will not be enough to ensure successful market entry by smallholders because of constraints in access to productive resources. Thus, promoting farm households' participation in agricultural markets requires that agricultural policy facilitates their access to improved technologies (such as fertilizer) and credit.

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