The Use of Mobile Money Application and Smallholder Farmer Market Participation: Evidence form Cote d'Ivoire and Tanzania

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Abstract:

With the growing food security concerns market participation of smallholder farmers has regained the attention of policy makers and agricultural development community. The widespread adoption of information and communication technologies in Sub-Saharan Africa over the last decade have paved the way for the introduction of digital solutions such as mobile money that have a potential to enhance access to input and output markets. Using a conceptual framework based on the Transaction Cost Economics theory, we propose a hypothesis that the ability to make quick and low-cost money transfers through mobile money application can lower the transaction costs associated with hold-up risks of participating in distant markets. This hypothesis is tested using the data from the CGAP survey in Cote d'Ivoire and Tanzania. The methods include Heckman Probit model to account for sample selection bias. The findings indicate that the stallholder farmers who use the mobile money for receiving payments from buyers are more likely to sell their product in city and regional markets versus farm gate options such as middleman and village markets.
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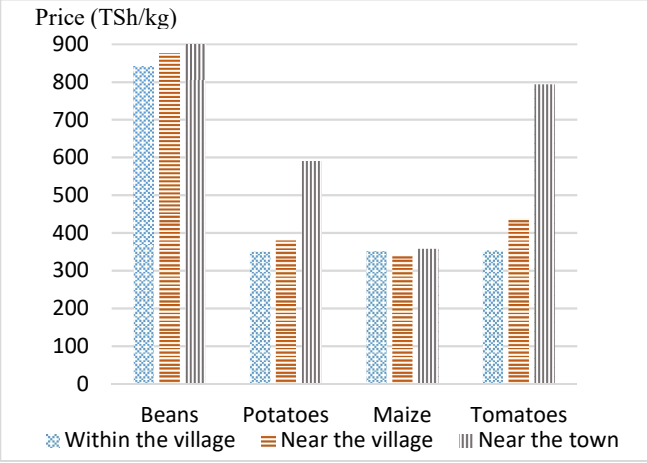
Introduction

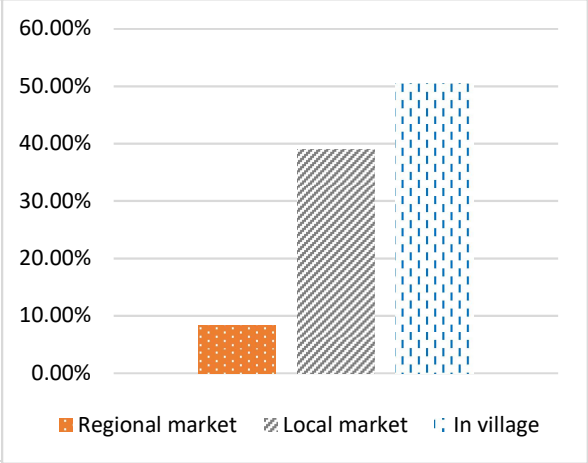
The limited market participation and high transaction costs faced by smallholder farmers in developing and emerging economies is widely documented in the literature (Alene et al., 2008; Benfica et al., 2017; Staal et al., 1997). This is particularly true in Sub-Saharan Africa. Despite the higher prices for staples such as maze, rice, and wheat in urban markets and regional trade hubs, majority of smallholder farmers in Sub-Saharan African countries resort to sale at the farm gate or subsistence farming (de Janvry et al., 1991). The recent data from Tanzania revealed that while the distant markets offer higher prices compared to farm gate options (World Bank, 2016), only 2% of the farmer surveyed sold their produce in the regional markets, 40% sold to local markets (near towns), while more than 50% of the farmers sold their products at the farm gate - either to a middleman or to their neighbors (CGAP, 2017). According to the same survey, main barriers to market participation reported by farmers include high transaction costs associated with (a) the distance to markets and transportation costs, (b) limited access to market information and search costs, and (c) risk of hold up faced by farmers when dealing with buyers in distant town and regional markets (Henning and Henningsen, 2007; Key et al., 2000) (Figure 1 (a) and (b)).

Figure 1(a): Beans, Potatoes, Maize and Tomatoes prices in selected Market in Tanzania



Source: Tanzania National Panel Survey 2014-2015. World Bank, 2017

Figure 1(b): Percentage of households selling to selected markets in Tanzania



Source: CGAP, 2016

Recent literature has shown that the majority of programs designed to promote market participation by reducing transaction costs have relied on collective marketing strategies through establishment of cooperatives or associations (FAO, 2014). While such third-party interventions help lower transactions costs through economies of scale and enhanced bargaining power, they have had limited long-term sustainability after the withdrawal of third-party assistance (Shanoyan et al., 2014). Another body of literature presents an argument that farmers would participate more in markets if they switch from staple crops to commercial crops or opt for an extended range of cultivated crops (Jayne, 1994). Yet the prominence of transaction costs remains a major constraint to market participation (Barrett, 2008). Addressing the issue of high transaction costs requires innovative and sustainable strategies that align with the dynamic reality of rural households.

The digital revolution in the last decade has paved the way for wide-scale digital technologies such as mobile technologies that could be leveraged to provide market-driven solutions to smallholders agricultural challenges. There has been a large scale adoption of these new technologies in various developing countries. Examples of applications of these technologies include mobile payments, market information via mobile phone, mobile banking etc. Today, mobile banking has the potential to increase financial inclusion of smallholder agricultural producers and improve their access to input and output markets.

Recent studies in agricultural development have shown that the use of mobile money has a general positive impact on household welfare (Kikulwe et al., 2014; Suri and Jack, 2016). Digital payments impact household income through four pathways: remittances, use of purchased inputs, sales of inputs and employment. Jack and Suri (2014) investigate the impact of mobile money transactions in smoothing consumption through remittances in Kenya. They conclude that digital payments-based remittances contribute significantly to deal with consumption shocks in rural communities through risk sharing. The impact of digital payment on agricultural output sales has received scant attention and the mechanism through which mobile money could impact output sales remains unclear. Therefore, it is important to identify this mechanism to envisage the role that could play digital payments in providing sustainable commercial strategies.

The objective of this study is to investigate the role of digital payment in smallholder market participation in Cote d'Ivoire and Tanzania, focusing on participation in distant markets which

pay higher prices than farm-gate or village markets. The next section presents the conceptual framework of market participation under transaction costs. The data used in the analysis are presented in the third section, and the empirical model is developed in the fourth section. The fifth section presents the results of the study and related discussion.

Conceptual Framework

Transaction costs and market participation in developing countries

Transaction cost economics provides a good framework for studying market participation. Farmers will sell to a regional market if the difference in prices between regional and village market is higher than the additional transaction costs generated from selling to the regional market. Considering a regional market r and a local market l which could consist in a farm gate transaction, choosing the regional market requires the difference in profits to be higher than the difference in transaction costs:

$$(\Pi_r - \Pi_l) - (TC_r - TC_l) > 0, \quad (1)$$

where Π_i is the farmer's gross profit from selling her products on market i after deduction of the production cost and TC_i denotes the transaction costs.

Transaction costs are defined in the literature using several categories. One of the categorization includes fixed and proportional transaction costs (Key et al., 2000). Fixed transaction costs include (a) the cost of searching for a customer with the best price, (b) negotiation and bargaining, (c) screening, monitoring and enforcing an agreement. The proportional transaction cost includes the per-unit cost of accessing markets and are generally associated with transportation and handling. Key et al., (2000) show that both categories impact market participation decisions. (Holloway et al., 2000) underline the barriers to market participation by more resource-constrained smallholder farmers created by transaction costs. When not observable, the distinction between fixed and proportional transaction costs can be performed by estimating a minimum threshold level corresponding to the fixed transaction cost as in Cogan (1981), Key et al. (2000), Makhura et al. (2001) and Henning and Henningsen, (2007).

Modeling market participation

In this analysis, we model the farmer's decision to sell his products on a market accounting for transaction costs, assuming that the seller' marketing decision can be modeled as a choice

between the following alternatives: selling in the village to neighbors, selling to a middleman, selling on a local market or selling to a regional market. The net-seller farmer will sell his products to a market i if the net profit derived from selling on market i is higher than the net profit from selling on each of the other alternatives.

To account for more than two alternative markets, the net seller's decision could be represented using the following framework. Let m_i be the i^{th} market among J available markets and Π_i the farmer's net profit from selling his production to market m_i. The net-seller chooses the market m_i that provides the highest profit:

$$m_i = \underset{i}{\text{argmax}}\{\Pi_i = q_i(p_i - C - TC_i^v) - TC^f, i = 1, \dots, J\} \quad (2)$$

where q_i is the quantity sold by the farmer, p_i is the expected price on market i, TC_i^v and TC^f denote respectively the variable and fixed transaction costs and C the production cost.

The quantity q_i to be sold is the quantity produced after deducting the quantity consumed by the household. The variable transaction costs are a function of the distance d_i, the time t_i to reach the market i, and other specific characteristics z_i^v , such as the road quality. The fixed transaction costs TC^f is the value of the investment made by the farmer for obtaining information about potential buyers, prices, agreements available, and enforcing the transaction terms. The fixed transactions costs are invariant to the quantity sold function include the search costs z_i^f and the perceived risk for hold-up, which includes ex-ante investment k to prevent hold-up and ex-post enforcement j. Ex-ante investment include actions to prevent the buyer to renegotiate the price and try to extort the quasi-rent once the product reaches the market. The farmer incurs ex-post enforcement costs to ensure her full payment collection. Both ex-ante investment and ex-post enforcement costs are function of the transaction asset specificity s. Peterson et al. (2001)'s concept of transaction specific assets provides support to accounting for ex-ante and ex-post costs. Transaction specific assets are different to general purpose assets in the senses that the former are tailored to a particular transaction and maintain their value only in a limited range of alternative transactions. The ex-ante and ex-post costs are written as k= k(s) and j = j(s). The price p_i includes an exogenous price component and an expected price markup that depends on the farmer's bargaining ability (b). Education, experience, product quality as well as other sources of income and assets will affect the farmer's bargaining ability. Then the farmer's marketing decision problem can be explicitly stated as:

$$m_i = \underset{i}{\text{argmax}}\{\Pi_i = q_i(\bar{p}_i + p_b(q_i, b) - C - TC_i^v(d_i, t_i, z_i^v)) - TC^f\left(z_i^f, k(s), j(s)\right), i = 1, \ldots, J\} \quad (3)$$

Given the risk for hold-up, the use of digital payments reduces ex-ante and ex-post hold-up investment costs through signaling mechanism from the buyer. The comparative statics resulting from the first order condition in (3) predict an increase in market participation as a result of lower transaction costs. In other words, the hypothesis to be tested in the analysis is that the use of mobile money increases distant market participation, which encompasses markets located near the town and regional markets.

Data

The study uses a cross-sectional household-level dataset from the CGAP's national survey of smallholder households conducted in Tanzania from February to March 2016 and Cote d'Ivoire from April to May 2016. The target population of the survey consisted of the entire community of smallholder farmers in both countries. The sample of the study includes a total of 6175 households obtained by combining the two individual country samples. The stratified multistage sampling covering all regions and rural-urban classification zones in both countries ensured a sample that is nationally representative of the smallholder household community. CGAP identified the target population by referring to 9 criteria: market orientation, landholding size, labor input, income, farming system, farm management responsibility capacity, legal aspects and level of organization. In addition, to be included in the sample, households had to depend on farming as the main income source, and own a sufficiently small land area or livestock herd.

As it pertains to Cote d'Ivoire, the sample included households from three agricultural zones of the country: East Forest, West Forest, and Savanna. The sampling led to 3,333 target households in 233 enumeration areas (EA) out of the 18,321 EA identified by the National Statistical Office (INS) for the agricultural census. From these 3,333 households, 3,019 were interviewed at an attrition rate of 9.42%. The Tanzania survey targeted 3,156 households in 212 enumeration areas and 5 regions defined for the purpose of the survey: Border, Coastal, Inland, Lake, and Zanzibar. The interview was successfully conducted for 2,993 households out of 3,156, resulting in an attrition rate of 5.16%.

The data used in the analysis are based on a randomly selected household member among the ones who contributed to the household income and aged 15 and over.

Market participation and mobile money use

Figure 1(b) presents the different types of markets visited by smallholders to for commercial purpose. In Tanzania, like in most countries in Sub-Saharan Africa, the majority of smallholders (more than 75%) market their harvest either in the village or to a traveling merchant. Fewer farmers travel to distant markets including local and regional markets to sell their harvest (less than 40%). This low access to distant markets is highlighted by an important body of market participation literature (Mmbando et al., 2015; Renkow et al., 2004; Shiferaw et al., 2011). The high transaction costs resulting from the poor infrastructure and market imperfections contribute to render markets hardly accessible to smallholders (Shiferaw et al., 2011).

Figure 2(a) presents the proportion of market participants among mobile money users and Figure 2(b) shows the proportion of market participants among mobile phone owners. Among mobile money users, we observe a larger proportion of markets participants (56%) than with their non-user counterparts (39%). This suggests a correlation between market participation and mobile money use, supported by the less significant difference in market participation rates between mobile phone holders and non-holders. That is, having a mobile phone is not necessarily associated with higher market participation but using this account to make commercial transaction does reflect a higher market participation.

Figure 2(a): Market participation among mobile money users

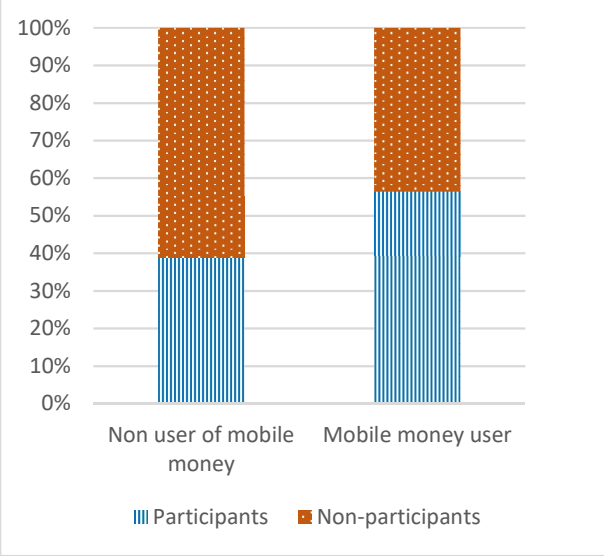


Figure 2(b): Market participation among Mobile phone owners

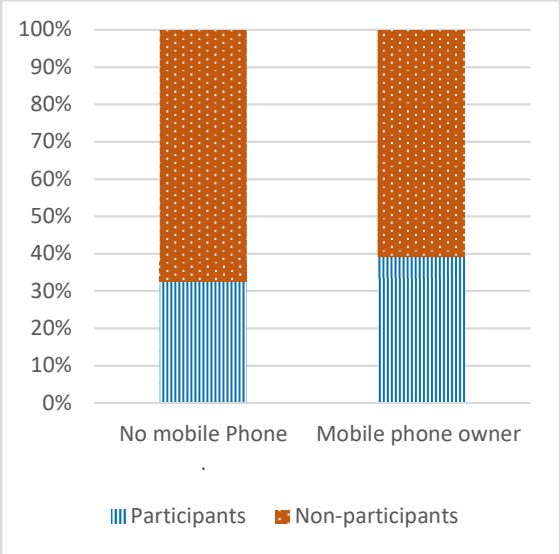


Table 1 presents a summary of the variables used in the model specification. The variable distant market includes both regional markets and local markets, that is markets located near agglomerations or towns. A response is observed for distant market participation for 82% of the sample with 38% of the household effectively participating in distant markets. The income amount is converted from Cote d'Ivoire XOF and Tanzania Shillings to USD dollars using the exchange rates of the date of the survey implementation. The variable land includes both own and rented land in acre. About 170 farmers in the sample make commercial transactions through mobile money with 52% of these smallholders located in rural area, which makes a reasonable balance between users in rural and urban areas.

The rate of complete observations in the variables of the model is relatively high excepted for commercial mobile money and education.

Table 1. Sample descriptive statistics

Description	N	Mean	Std. Dev.
Selling to distant market (Yes = 1, No = 0)	4588	0.38	0.4859498
Using mobile money for commercial purposes (Yes = 1, No = 0)	2548	0.07	0.2495837
Gender (Male = 1, Female = 0)	5565	0.56	0.4958304
Number of years in school (mid values) Continuous (Mid values)	3228	4.86	3.258277
Age in years	5565	42.05	15.31074
Age squared	5565	2002.24	1464.993
Number of individuals in the household	5565	5.30	2.954363
Income in USD	5258	116.15	207.8853
land in acre	5264	59.49	63.30806
Number of years of farming experience (mid values) Continuous	5192	11.39	4.897747
Member of a cooperative (Yes = 1, No = 0)	5225	0.07	0.2590823
Receive market price information through cellphone (Yes = 1, No = 0)	5225	5.65	11.43483
Growing rice (Yes = 1, No = 0)	5264	0.67	0.4694882
Household own livestock (Yes = 1, No = 0)	5264	0.45	0.4970449
Household lives in a rural area (Rural = 1, Urban = 0)	5565	0.77	0.4192513
Country of the household (Tanzania = 1, Cote d'Ivoire = 0)	5565	0.49	0.4998608
Number of cell phones in the household	3,928	3,928	0.3453298

Empirical model estimation

To investigate the determinant of market participation, a probit model with sample selection is estimated using a Heckman two-step procedure. The motivation for the Heckman probit model stems from the potential bias that may arise with the missing market participation data. This causes the sample to be drawn from a special subpopulation of the initial representative sample (Kennedy, 2008) and makes the resulting inference inaccurate. The instrumental variable estimation (IV) could address the issue of non-random sample selection but finding a suitable IV remains challenging (Kennedy, 2008), particularly for a new payment system such as mobile money.

The base model requires the outcome variable to represent two mutually exclusive choices. The exclusivity requirement is not satisfied when households select more than one type of market in their search for the optimal marketing decision (farm-gate, village, local and regional market). In this study the distance market includes local and regional markets, in other words markets access to which entails travel/transportation. Because the distant market variable is constructed upon the only participation in local or regional markets, the dependent variable market participation satisfies the exclusivity condition. Another important requirement of the probit model is the joint normality of the unobserved factors (Train, 2009), which is assumed to hold in the current model specification.

The sample selection model corrects for sample selection bias but not for endogenous treatment effect. The market participation decision and the commercial use of mobile money may be simultaneously determined by underlying factors such as ability. The treatment effect model deals with the potential bias from endogenous treatment (Ma and Abdulai, 2017). By estimating a sample selection model and comparing the estimated model to a treatment effect model, inferences can be drawn confidently in case of similar estimates.

Heckman Probit sample selection model

The basic probit model is specified as follows. Let y* denote the unobserved utility derived by the household from participating in the market, with:

$$y_i^* = \beta' x_i + \varepsilon_{1i} \quad (4)$$

where x_i is a vector of covariates, β' a vector of parameters and ε_{1i} the vector of error terms.

The household market participation decision y will take the value of 1 for y* > 0 and the value of 0 otherwise. The choice probability is given by:

$$\text{Prob}(\text{y} = 1|\text{x}) = \int_{-\infty}^{x'\beta} \phi(v)dv \quad (5)$$

where $\phi(z)$ denotes the standard normal distribution: $\phi(v) = (2\pi)^{-1/2} \exp(-z^2/2)$

The vector x in this study includes four set of variables representing the commercial use of mobile money, the price premium, the variable and the fixed transaction cost specific to each market participation decision. To construct the variable transaction costs, we need to capture the distance between farm and market, the time to reach the market and other characteristics such as the road quality. The price premium is correlated with the distance (Figure 1(a)). Thus the price in equation 3 is proxied by the distance variable which is a dummy for household experiencing distance challenge in accessing markets. In this analysis, the variable transaction cost is comprised of a set of factors that impact market access including the livestock ownership, cooperative membership, and rural location. The fixed transaction cost encompasses proxy of household's marketing. The important marketing ability proxies are household demographics and farmer characteristics as in (Alene et al., 2008; Bellemare and Barrett, 2006; Burke et al., 2015; Martey et al., 2017).

The marginal effects of the probit model are computed following (Greene, 2012):

$$\frac{\partial E[z|x]}{\partial x} = \phi(\beta' x_i)\beta \quad (7)$$

The first stage of the Heckman procedure consists of the selection mechanism. Following (Van de Ven and Van Praag, 1981) a variable response behavior δ is defined for each household in the sample. The variable δ equals 1 when a response is observed for market participation and zero otherwise. The response propensity which is the probability of δ being one is estimated following the standard probit procedure defined in equations (4) and (5). The unobserved response propensity I^* is given by:

$$I_i^* = \gamma' z_i + \varepsilon_{2i} \quad (7)$$

where z_i denotes a vector of explanatory variables, γ' is a vector of parameters and ε_{2i} the vector of error terms. A response is observed for $I_i^* > 0$. The error terms in the main equation and the selection equation are assumed bivariate normally distributed with $\text{corr}(\varepsilon_{1i}, \varepsilon_{2i}) = \rho$. The vector z_i is represented by non-response behavior proxies comprising age, education, gender and zone as in (Van de Ven and Van Praag, 1981).

In the second stage of the procedure, the inverse Mills ratio is added to the regression equation of market participation for the respondent subsample, specified as follows:

$$Prob(y_i = 1) = \beta' x_i + \rho\lambda_i + \tilde{\varepsilon}_{1i} \quad (8)$$

where x_i is a vector of covariates and λ_i is the inverse Mill's ratio computed as $\lambda_i = \phi(\gamma' z_i)/\Phi(\gamma' z_i)$. In case of bias arising from non-response in the sample selection, including λ_i as covariate will result in unbiased coefficients (Heckman, 1979; Van de Ven and Van Praag, 1981).

Treatment effect model

An alternative specification is formulated using a treatment effect model where the treatment is the commercial use of mobile money and the outcome is market participation. This model specified for the purpose of a robustness check accounts for potential endogeneity, since the same observed and unobserved factors that influence the household's decision to use mobile money may also affect the market participation decision. The average treatment effect (ATE) of mobile money is estimated using the Inverse probability of treatment weighting described in (Austin and Stuart, 2017).

Results

In this analysis, the Heckman probit is estimated in two stages, the sample selection and the probit model with sample selection correction term. The sample selection model is estimated under the main hypothesis that incomplete observation leads to bias estimates. Table 2 reports the results of the sample selection model and Table 3 presents the estimates of the probit model with and without the sample correction term. In the sample selection equation, the dummies *Zone* are added to the vector of explanatory variables to account for the location of the respondent.

Including these variable to the sample selection improves the identification of the model. In order for the model to be identified, the vector of explanatory variables of the sample selection model must have at least one covariate that is not included in the main probit equation.

Sample selection model

The main variables explaining the response behavior are *age*, *gender,* and *region*. As expected, males are more likely to respond to all questions than female since males are mainly the heads of households and take the important decisions in most Sub-Saharan Africa countries. Older individuals are less likely to take the full survey, according to the results of the selection model regression, consistent with (Van de Ven and Van Praag, 1981). This is reasonable since generally older individuals are expected to devote less time to the survey than their younger counterparts. The estimates of region dummies reveal two patterns of survey completion across regions and countries. First, The East forest region of Cote d'Ivoire presents the highest rate of complete survey. This is not surprising given the high literacy in this region. In addition, the smallholders of the Coastal, Inland, Lake and Zanzibar regions of Tanzania are less likely to fully take the survey than their Ivorian East forest counterparts, which suggests a higher survey completion rate in Cote d'Ivoire.

Table 2. Sample selection results

Variable	Coefficient		Std Err.
Age	-0.0050	**	0.0021
Gender	0.3518	***	0.0619
Education	-0.0079		0.0102
Zone (Base = East Forest)			
West Forest	-0.0599		0.1206
Savannah	-0.2959	*	0.1611
Border	-0.0598		0.1310
Coastal	-0.2760	**	0.1191
Inland	-0.2709	**	0.1151
Lake	-0.4627	***	0.1225
Zanzibar	-2.0119	***	0.3363
Constant	0.8059	***	0.1346
N			2048
Log-likelihood			-1194.6374

Market participation model

The estimates of the Heckman Probit model accounting for sample selection bias are discussed in this section. The marginal effects presented in Table 4 represent the change in the probability of distant market participation associated with each explanatory variable. The model fits the data reasonably; the Wald test of the hypothesis that the correlation coefficient $\rho = 0$ is rejected at the 1% significance level. Thus, the estimates of the market participation equation are biased by the missing observations. Compared to the estimates of the model without sample error correction term, the Heckman probit presents smaller estimates of magnitude which confirms the bias. Excepted the experience of the farmer, the two models predict the same determinants of market participation. Another difference between the two sets of estimates is the significance level of Male and Household size which increase in the Heckman Probit model.

Commercial mobile money use is associated with a higher market participation as expected. The use of mobile money increases the likelihood of market participation by 8 percentage points (Table 4). Mobile money is the third most important determinant of market participation after the distance and rural location. Other determinants of market participation include Household size, Male, price information and rice dummy.

The distance variable is a dummy for smallholders indicating the distance as a challenge to access markets. In fact, the distance is associated with higher market prices (Figure 1(a)) and constitutes a proxy for the commodity price in the market participation model (Equation 3). Since the model predicts that market participation increases with higher prices, the sign of the distance estimate is consistent with the model prediction.

The transaction cost includes variable transaction cost and fixed transaction cost, with the later comprised of search costs. The variable transaction cost is expected to reduce participation in distant market. As in Okoye et al. (2016), the location in rural area which indicates the remoteness of smallholders from distant market decreases the likelihood of distant market participation as expected by 9%, with a 1% significance level. The estimates of the marginal effects (Table 4) show that the reduction of the search costs through enhanced marketing capabilities is associated with a higher market participation. As in Bellemare and Barrett (2006) and Okoye et al. (2016), female-headed households are less likely to sell their products to the market. Two other factors affect directly search cost: price information and rice production.

Receiving price information through SMS improves the likelihood of market participation as in Ouma et al. (2010). Rice is the crop grown for commercial purpose by the majority of the respondent (64% of the respondent). The high demand for this staple in urban areas may reduce the search costs associated with rice marketing. As in Martey et al. (2017), multiple person households have a higher likelihood of market participation, with 1% additional probability for each additional household member.

Table 3. Estimated Probit without and with sample correction

	Without correction			With correction		
Variable	Coefficient	.	Std. Err	Coefficient	.	Std. Err
Mobile money	0.3218	**	0.1370	0.2586	**	0.1123
Distance	0.4341	***	0.0709	0.3601	***	0.0597
Household size	0.0345	***	0.0132	0.0256	**	0.0110
Income	0.0001		0.0003	0.0001		0.0002
Male	0.1456	*	0.0758	0.2579	***	0.0675
Age	0.0073		0.0144	0.0036		0.0119
Age squared	-0.0001		0.0002	-0.0001		0.0001
Education	-0.0054		0.0132	-0.0080		0.0115
Cooperative	-0.1685		0.1367	-0.1585		0.1187
Livestock ownership	-0.0235		0.0734	-0.0068		0.0600
Rural	-0.3317	***	0.0783	-0.2735	***	0.0690
Experience	-0.0137	*	0.0078	-0.0106		0.0066
Land	-0.0009		0.0007	-0.0007		0.0005
Price information	0.0065	**	0.0031	0.0054	**	0.0025
Rice	0.1910	**	0.0901	0.1687	**	0.0759
Country	0.0851		0.1194	-0.0157		0.1057
Constant	-0.5278		0.3307	-0.7386	***	0.2755
Correlation coefficient				0.8432		0.0994
λ				1.2323		0.3441
N	1432			2048		
Likelihood ratio	107.10			99.27		

Table 4. Marginal effects of the Probit model with and without sample correction

	Without correction		With correction	
Variable	Coefficient	Std. Err.	Coefficient	Std. Err.
Mobile money	0.1182**	0.0500	0.0863**	0.0375
Distance	0.1594***	0.0250	0.1202***	0.0197
Household size	0.0127***	0.0048	0.0085**	0.0037
Income	0.0000	0.0001	0.0000	0.0001
Male	0.0535*	0.0277	0.0860***	0.0223
Age	0.0027	0.0053	0.0012	0.0040
Age squared	0.0000	0.0001	0.0000	0.0000
Education	-0.0020	0.0049	-0.0027	0.0038
Member of a cooperative	-0.0619	0.0501	-0.0529	0.0395
Livestock ownership	-0.0086	0.0269	-0.0023	0.0200
Rural	-0.1218***	0.0282	-0.0912***	0.0231
Experience	-0.0050*	0.0028	-0.0036	0.0022
Land	-0.0003	0.0002	-0.0002	0.0002
Price information	0.0024**	0.0011	0.0018**	0.0008
Rice	0.0701**	0.0329	0.0563**	0.0253
Country	0.0312	0.0438	-0.0052	0.0353

Treatment effect model

Recognizing the potential bias from the self-selection of mobile money users, we run an additional specification with treatment effect. The estimates of the treatment effect model are reported in Table 5. The commercial mobile money use is associated with an increase in the likelihood of market participation, which is about twice the prediction of the Heckman Probit model. However, the treatment effect model estimates are sensitive to the explanatory variables included in the selection equation. Since there is a limited body of literature addressing the determinant of mobile money adoption, the set of explanatory variables is selected with no prior evidence. Yet, the estimate of the Average Treatment Effect is qualitatively consistent with the prediction of the Heckman Probit model. Factors associated with commercial mobile money adoption include education, age and the number of cell phones in the household, as in Kikulwe et al. (2014).

Table 5. Estimates of the treatment effect model

Variable	Coefficient	Std. Err.
Average Treatment Effect	0.1744***	0.0568
Income	0.0000	0.0003
Male	-0.0262	0.1135
Education	0.0369***	0.0135
Age	0.0543**	0.0262
Age squared	-0.0007**	0.0003
Rural	-0.1813*	0.1099
Number of cell phones	0.3089***	0.1157
Constant	-2.8623***	0.5889
N		1328

The analysis presents evidence of positive effect of commercial mobile money use on market participation. Yet, the results are specific to Cote d'Ivoire and Tanzania which are among the pioneering nations in the large-scale adoption of mobile money, especially in rural area. One limitation of the analysis is that the Heckman Probit model corrects for selection bias accounting for only 17.5% of the missing observation. But given the relatively large sample (5565 observations) the results present substantial robustness. Further areas to explore include the effect of commercial mobile money on the quantity sold to distant markets.

Conclusion

The large-scale adoption of mobile money in Sub-Saharan African countries presents an opportunity to examine the impact on farm performance including the market participation. In this study, we examine the impact of mobile money on transaction cost associated with participation in distant markets. It is hypothesized that the use of mobile money can have a positive impact on participation in distant markets by reducing transaction costs associated with the risk of hold up. The results of the analysis conducted on Cote d'Ivoire and Tanzania data indicated that the use of mobile money for receiving payments increases the likelihood of participation in distant market by eight percentage points. Other determinants of market participation include distance, household size, male-headed households, location in rural area, price information and commercial orientation of the household.

The impact of mobile money use has been mainly analyzed by focusing on the overall use of mobile money regardless of the purpose of the transaction. The results of this study contribute to the literature by providing insight on the role of digital payment in improving market participation. The conclusions of the analysis should be generalized with care since Cote d'Ivoire and Tanzania are known for their rapid adoption of mobile technologies in both rural and urban areas. Further studies analyzing the impact of mobile money on quantities sold to distant markets should shed light on the magnitude of this effect.

References

Alene, A.D., Manyong, V.M., Omanya, G., Mignouna, H.D., Bokanga, M., and Odhiambo, G. (2008). Smallholder market participation under transactions costs: Maize supply and fertilizer demand in Kenya. Food Policy *33*, 318–328.

Austin, P., and Stuart, E. (2017). Estimating the effect of treatment on binary outcomes using full matching on the propensity score. Stat. Methods Med. Res. *26*, 2505–2525.

Barrett, C. B. 2008. Smallholder market participation: Concepts and evidence from eastern and southern Africa. Food Policy 33 299–317.

Bellemare, M.F., and Barrett, C.B. (2006). An Ordered Tobit Model of Market Participation: Evidence from Kenya and Ethiopia. Am. J. Agric. Econ. *88*, 324–337.

Benfica, R., Boughton, D., Uaiene, R., and Mouzinho, B. (2017). Food crop marketing and agricultural productivity in a high price environment: evidence and implications for Mozambique. Food Secur. 1–14.

Burke, W.J., Myers, R.J., and Jayne, T.S. (2015). A Triple-Hurdle Model of Production and Market Participation in Kenya's Dairy Market. Am. J. Agric. Econ. *97*, 1227–1246.

CGAP (2016). National Survey and Segmentation of Smallholder Households in Tanzania: Understanding Their Demand for Financial, Agricultural, and Digital Solutions. Available from: http://www.cgap.org/sites/default/files/Working-Paper-Smallholder-Survey-Tanzania-May-2016.pdf

FAO (2014). Understanding smallholder farmer attitudes to commercialization, the case of maize in Kenya.

Greene, W.H. (2012). Econometric analysis (Boston; London: Pearson).

Heckman, J.J. (1979). Sample Selection Bias as a Specification Error. Econometrica *47*, 153–161.

Henning, C.H.C.A., and Henningsen, A. (2007). Modeling Farm Households' Price Responses in the Presence of Transaction Costs and Heterogeneity in Labor Markets. Am. J. Agric. Econ. *89*, 665–681.

Holloway, G., Nicholson, C., Delgado, C., Staal, S., and Ehui, S. (2000). Agroindustrialization through institutional innovation: Transaction costs, cooperatives and milk-market development in the east-African highlands. Agric. Econ. *23*, 279–288.

Jack, W., and Suri, T. (2014). Risk Sharing and Transactions Costs: Evidence from Kenya's Mobile Money Revolution. Am. Econ. Rev. *104*, 183–223.

de Janvry, A., Fafchamps, M., and Sadoulet, E. (1991). Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained. Econ. J. *101*, 1400–1417.

Jayne, T. (1994). Do High Food Marketing Costs Constrain Cash Crop Production? Evidence from Zimbabwe. Econ. Dev. Cult. Change *42*, 387–402.

Kennedy, P. (2008). A Guide to Econometrics (Malden, MA: Blackwell Publishing).

Key, N., Sadoulet, E., and de Janvry, A. (2000). Transactions Costs and Agricultural Household Supply Response. Am. J. Agric. Econ. *82*, 245–259.

Kikulwe, E.M., Fischer, E., and Qaim, M. (2014). Mobile Money, Smallholder Farmers, and Household Welfare in Kenya. PLoS ONE *9*, 109–804.

Ma, W., and Abdulai, A. (2017). The economic impacts of agricultural cooperatives on smallholder farmers in rural China. Agribusiness *33*, 537–551.

Martey, E., Etwire, P.M., Wiredu, A.N., and Ahiabor, B.D.K. (2017). Establishing the link between market orientation and agricultural commercialization: Empirical evidence from Northern Ghana. Food Secur. *9*, 849–866.

Mmbando, F.E., Wale, E.Z., and Baiyegunhi, L.J.S. (2015). Welfare impacts of smallholder farmers' participation in maize and pigeonpea markets in Tanzania. Food Secur. *7*, 1211–1224.

Okoye, B.C., Abass, A., Bachwenkizi, B., Asumugha, G., Alenkhe, B., Ranaivoson, R., Randrianarivelo, R., Rabemanantsoa, N., and Ralimanana, I. (2016). Effect of transaction costs on market participation among smallholder cassava farmers in Central Madagascar. Cogent Econ. Finance *4*, 1143597.

Ouma, E., Jagwe, J., Obare, G.A., and Abele, S. (2010). Determinants of smallholder farmers' participation in banana markets in Central Africa: the role of transaction costs. Agric. Econ. *41*, 111–122.

Peterson, H.C., Wysocki, A., and Harsh, S.B. (2001). Strategic choice along the vertical coordination continuum. Int. Food Agribus. Manag. Rev. *4*, 149–166.

Renkow, M., Hallstrom, D.G., and Karanja, D.D. (2004). Rural infrastructure, transactions costs and market participation in Kenya. J. Dev. Econ. *73*, 349–367.

Shanoyan, A., Brent Ross, R., Gow, H.R., and Christopher Peterson, H. (2014). Long-term sustainability of third-party facilitated market linkages: Evidence from the USDA marketing assistance program in the Armenian dairy industry. Food Policy *46*, 157–164.

Shiferaw, B., Hellin, J., and Muricho, G. (2011). Improving market access and agricultural productivity growth in Africa: what role for producer organizations and collective action institutions? Food Secur. *3*, 475–489.

Staal, S., Delgado, C., and Nicholson, C. (1997). Smallholder dairying under transactions costs in East Africa. World Dev. *25*, 779–794.

Suri, T., and Jack, W. (2016). The long-run poverty and gender impacts of mobile money. Science *354*, 1288–1292.

Train, K. (2009). Discrete Choice Methods With Simulation (Cambridge University Press).

Van de Ven, W.P.M.M., and Van Praag, B.M.S. (1981). The demand for deductibles in private health insurance: A probit model with sample selection. J. Econom. *17*, 229–252.

World Bank (2015). 2014-2015 Living Standard Measurement Study [Data file and Code book]. Available from: http://microdata.worldbank.org/index.php/catalog/2862