Received: 18 October 2018 | Revised: 16 April 2019 | Accepted: 17 April 2019

DOI: 10.1002/isd2.12097

RESEARCH ARTICLE

WILEY

Smallholder farmers' market participation and mobile phone-based market information services in Lilongwe, Malawi

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Abstract

There has been growing interest in the development of technology-based systems to empower farmers in Africa. This paper determines the effect of mobile phone-based market information services (MIS) on farmers' decisions to participate in maize markets in Lilongwe, Malawi. The study reveals insufficient evidence to suggest that the MIS influence farmers' market participation decisions. Knowledge of prevailing prices may not necessarily guarantee farmers market participation, especially when buyers determine market prices and transaction costs are high. Consequently, farmers with no access to alternative markets fail to improve their marketing outcomes. The findings suggest that channelling government's resources towards improving extension services and increasing farmers' productivity are ideal ways to promote the participation of smallholder farmers in agricultural markets. The findings also underscore the need to integrate radio and mobile phones in agricultural MIS and to provide farmers with information related to agricultural production in addition to market prices. These recommendations could be realized through better coordination of market access initiatives involving smallholder farmers, government departments, NGOs, mobile network operators, and media houses.

KEYWORDS

agriculture, AMIS, ICT, Malawi, market information, MIS, mobile phones, smallholder farmers

1 | INTRODUCTION

A key focus of recent information and communication technology (ICT) and development initiatives in Africa has been to promote the use of mobile phones that can potentially improve smallholder farmers' access to information and markets (Aker & Ksoll, 2016; Misaki, Apiola, Gaiani, & Tedre, 2018; Steinfield, Wyche, Cai, & Chiwasa, 2015). This emphasis is based on the notion that agricultural sectors in developing countries predominantly comprise resource poor, small-scale subsistence farmers (Tadesse & Bahiigwa, 2015) who face high transaction costs (TCs) and have poor access to information that limit their market participation (Aker & Ksoll, 2016; Katengeza, Okello, Mensah, & Jambo, 2014; Martey, Annin, Wiredu, & Attoh, 2012). Effective use of ICT devices such as mobile phones is considered ideal in reducing asymmetries of information between traders and producers and subsequently reducing farmers' TCs (Deen-Swarray, 2016; Dixie & Jayaraman, 2011).

The Government of Malawi and development agencies within the country have been implementing ICT-based projects with the aim of providing market actors with market information services (MIS) to promote their market participation (IFPRI, 2013; Kunyenje & Chigona, 2019). One of the largest scale initiative is the Malawi Agricultural Market Information System (AMIS), with a mandate to provide farmers and traders with market information (Ministry of Agriculture and Food Security, 2011). However, an assessment of the AMIS in 2013 indicated that targeted users do not use the data for trade-related decisions because such information is normally disseminated in a website 3 months after compilation (IFPRI, 2013). The assessment revealed that there are similar projects implemented by Non-Governmental Organizations (NGOs) such as the Agricultural

Commodity Exchange (ACE), which disseminate market information via mobile phones instead of websites. Subsequently, the use of mobile phones has been intensively promoted to address the untimely dissemination of AMIS owing to increasing use of these devices (Figure 1).

The resolve to promote the use of mobile phone to disseminate agricultural information is based on the potential of these communication devices to reduce users' information search cost and enhance market participation (Katengeza et al., 2014). However, it is not yet established whether a significant number of farmers have access to MIS through the existing NGO's initiatives and if this access has led to increased market participation of smallholder farmers in Malawi. Furthermore, studies on the effect of mobile phone-based MIS conducted in other countries reveal mixed results as mobile phone penetration rates, farmers' literacy levels, and market dynamics differ across countries in Africa (Nakasone, Torero, & Minten, 2014).

Some studies suggest a significant effect of mobile phone-based MIS on farmers' market participation. Muto and Yamano (2009) reveal that banana growers in Uganda realized better prices after accessing market information through a mobile network. Nyarko, Hildebrandt, Romagnoli, and Soldani (2013) and Courtois and Subervie (2014) found that farmers with access to the ESOKO ICT-MIS received higher prices than those without access to the service in Ghana. Moreover, similar interventions are reported to have integrated resource poor farmers into a higher value agricultural chain in Kenya (Okello, Edith, Oliver, & Ruth, 2010).

Conversely, other studies suggest insignificant impact of mobile phone-based MIS on farmers' market participation. Tadesse and Bahiigwa (2015) found no effect of mobile phones on farmers' marketing decisions in Ethiopia, while Fafchamps and Minten (2012) found insignificant differences in price between people with and without access to an internet-based MIS in India. Baumüller (2013) found insufficient evidence for the effect of MFarm in Kenya, and a comprehensive review of ICT and its effect on agricultural development in developing countries found that access to mobile phones improved agricultural market performance at the macro-level but not at the micro-level (Nakasone et al., 2014). In Ghana where there has been significant effect of the ESOKO ICT-MIS, there were vigorous awareness campaigns and farmer training sessions prior to project implementation, and farmers who were beneficiaries received subsidized mobile phones and free annual subscription fees which was possible through external financing (Courtois & Subervie, 2014). Furthermore, it is important to note that Ghana has a high national mobile penetration rate which can reasonably account for the observed significant effects of ICT-based MIS.

Existing evidence suggests that ICT-based MIS in developing African countries have had significant effect in contexts where the implementation of such projects was highly subsidized using external financing, national mobile penetration rate was high, and farmers received thorough training on ICT devices (Steinfield et al., 2015). Existing evidence further suggests that the insignificant effect of ICT-based MIS is mainly attributed to low mobile phone penetration rates, poor infrastructure in rural areas, low farmer literacy levels, and challenges in market dynamics such as farmers' inability to access lucrative markets that cannot be fully addressed by provision of market information alone (Heeks, 2010; Makoza & Chigona, 2012; Tadesse & Bahiigwa, 2015). The latter scenario is comparable to the current context of Malawi (Kunyenje & Chigona, 2019; UNDP, 2018).

Therefore, the proposed development by the Malawian Government to enhance smallholder farmers' market participation through mobile phone-based MIS should be examined thoroughly to establish a priori its effect on target beneficiaries. This is because despite decades of investment in MIS programmes in other developing countries to address information asymmetries, evidence of their impact is mixed, and results tend to be country specific (Aker & Ksoll, 2016). To the best knowledge of the authors, the only related study conducted in Malawi assessed the effect of ICT-based MIS on farmers' TCs. No study has so far examined the effect of mobile phone-based MIS implemented by the NGOs to determine if such interventions have significantly enhanced smallholder farmers' market participation. Therefore, the main objective of this research was to determine the effect of the existing mobile phone-based MIS in Malawi on smallholder farmers' market decisions to ascertain if it would be a worthy investment for the Government to replicate the programmes within the country. There are three research questions that guided the study:

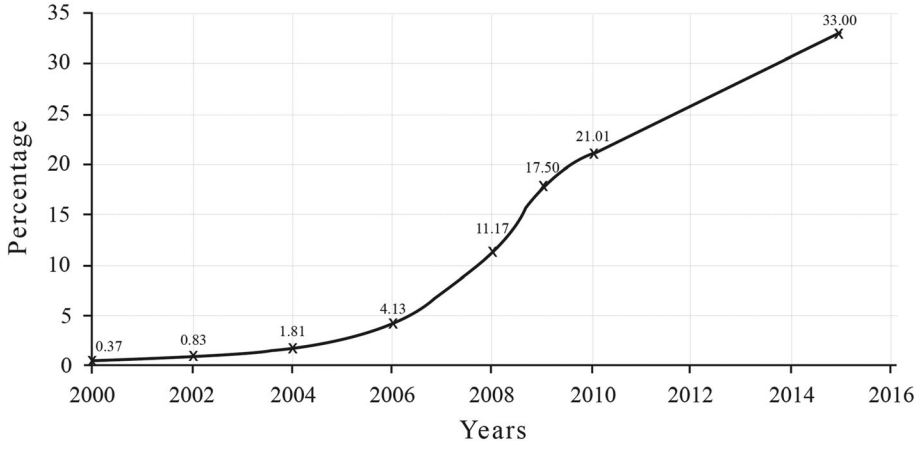

FIGURE 1 Trend of mobile phone subscription in Malawi
Source: Malawi National Statistics Office (2014).

(a) Do smallholder maize farmers in Malawi who use mobile phone-based MIS make different marketing decisions (whether to sell or not, where to sell the produce, and volume to sell) from those who do not use the service? (b) Do these farmers receive higher prices than non-users? (c) What are the determinants of smallholder farmers' participation in the maize market?

2 | CONCEPTUAL FRAMEWORK

Farmers' market participation is regarded as a decision on whether to sell or not along with the volume to be sold (Baumüller, 2013; Gani & Hossain, 2015). Asset-based and TCs are the two main approaches identified to guide farmers' market participation decisions. The asset-based approach hypothesizes that farmers' market participation will be associated with asset endowments (Boughton, Mather, Barrett, Benfica, & Abdula, 2007), whereas the TC approach hypothesizes that such a decision is more likely be associated with the cost of arranging and carrying out transactions such as negotitating prices and searching for additional information (Alene et al., 2008). What defines TCs is a subject that has been thoroughly studied by scholars. Many studies indicate that TCs depend on the nature of the transaction and the extent of information asymmetry and search (Tadesse & Bahiigwa, 2015). Kirsten, Doward, Poulton, and Vink (2009) and Martey et al. (2012) reveal that lack of perfect and freely available information leads to inefficient and subsequently higher cost market transactions which can potentially limit farmers' participation. ICT-based MIS are theoretically believed to reduce the information assymetry, and consequently, concepts from TC economics are considered important for this study as they associate the cost of information with farmers' market participation (Kirsten et al., 2009; Nakasone et al., 2014). Nonetheless, concepts from the asset-based approach are also incorporated because farmers need to own ICT tools to access ICT-based MIS (Tadesse & Bahiigwa, 2015). The way asset endowment and TCs affect farmers' access to ICT-based MIS is illustrated in Figure 2.

It is worth noting that farmers with limited access to and control over resources tend to be subsistence farmers who have limited incentives to participate in agricultural markets even when TCs are low. On the contrary, farmers with better access to and control over resources are more likely to be willing to adopt new innovations and incur some TCs to get critical support services as they strive to produce for their own consumption and other consumers. Thus, they tend to invest more in agriculture and produce a surplus. Therefore, their abilities to produce over their consumption requirements and access major markets should dictate whether to contemplate marketing their produce at farm level or beyond. This decision is vital for smallholder farmers to assess whether incurring costs to access ICT-based MIS and undertaking other market transactions results into better outcomes.

The study perceives mobile phone-based MIS to be more relevant for smallholder farmers in Malawi because these devices allow them to access information immediately and more frequently than other ICT-based MIS such as radio broadcasts and newspapers. Moreover, the devices allow smallholder farmers to assume an active role in searching for relevant information from multiple sources. In general, mobile phone-based MIS are more accessible than other alternatives in terms of search cost and geographic coverage (Malawi National Statistics Office, 2014). The authors support the view that mobile phones allow households to obtain information about potential shocks, which can be effectively used in production and marketing decisions (Aker & Mbiti, 2010; Gani & Hossain, 2015; Katengeza et al., 2014; Nmadu, Aiyelitsoya, & Sallawu, 2013) thereby determining outcomes from such decisions (Gani & Hossain, 2015; Maponya et al., 2015; Musah, Bonsu, & Seini, 2014).

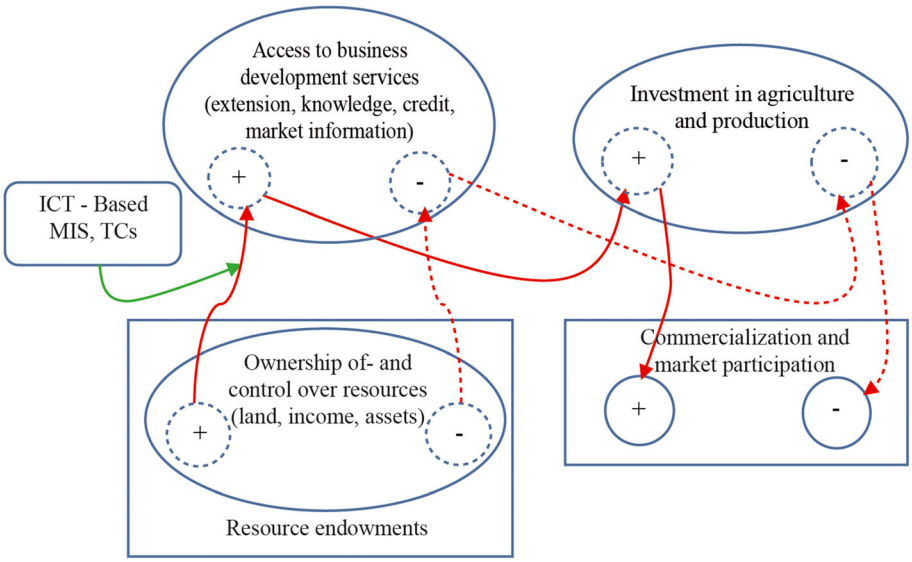

FIGURE 2 Conceptual framework

The study seeks to provide empirical evidence from Malawi with respect to three issues: firstly, the role mobile phone-based MIS play to influence farm-level production and marketing decisions. The interest is to assess differences between farmers with and without access to mobile phone-based MIS with respect to variables such as maize acreage, volume of maize sold, and choice of market outlets. Secondly, the effect of different market outlets on gains for these two categories of farmers focusing mainly on per unit price of maize sold; and lastly, key factors underlying smallholder farmers' decisions to take part in markets. The analysis of key issues underlying the study was based on descriptive and inferential statistics collected during the survey and qualitative analysis of information collated during focus group discussions.

3 | CONTEXT OF THE STUDY

Like in many other countries, in Southern Africa maize is the major staple and cash crop for small holder farmers in Malawi (Sassi, 2015; Shiferaw, Prasanna, Hellin, & Bänziger, 2011). In terms of policy, state intervention in its production and marketing is perceived to be vital to ensuring people's access to food (Chilowa, 1998; Dorward & Chirwa, 2011) because food prices are more volatile than elsewhere in the region. Smallholder maize farmers in Malawi face unique market challenges based on their production levels and distance from either rural or urban markets. Jayne, Sitko, Ricker-Gilbert, and Mangisoni (2010) identifies three categories of farmers namely: (a) Farmers in areas where there are well-developed markets with permanent buying points and occasionally specific market days. These markets have relatively high degree of competition between buyers (eg, private assemblers, mobile traders, and seasonal buyers serving as agents for large trading companies); (b) Farmers in rural regions where there are relatively few markets and marketing is restricted to specific days/periods of a week or month. The main buyers are itinerant traders and local buyers from nearby regions although there is notable temporal and spatial variation in market activities; and (c) Farmers in more isolated regions where maize is mainly bought by mobile traders who come to periodic regional markets along with traders with bicycles who are capable of buying small quantities of maize. Farmers in these remote areas can hardly contemplate taking maize to alternative markets.

Malawi has an estimated population of 17.7 million of which 85% are living in rural areas (Malawi National Statistics Office, 2014) where power supply is inadequate and telecommunication infrastructure is weak. Moreover, Malawi has other social challenges such as low literacy levels and low incomes. Its human development index (HDI) value for 2017 was 0.477, and its gross national income (GNI) per capita expressed in purchasing power parity (PPP) was 1064. Thus, Malawi is among the countries with low HDI. These challenges can potentially hinder the adoption and effective use of ICTs (Kunyenje & Chigona, 2019).

In view of this variation in market access across the regions, as well as obstacles in accessing ICTs including mobile phone services, it is expected that there will be notable differences between farmers not only with respect to their readiness to adopt mobile-based MIS but also use efficiency when they adopt. These difference are also expected to vary remarkably between urban and rural areas because the proportions of users of mobile phones are estimated to be around 72% and 31% of the populations in the areas, respectively (Malawi National Statistics Office, 2014). The study explores implicitly such differences so as to inform future policies aiming at enhancing farmers' market access and participation through MIS interventions.

4 | METHOD

4.1 | Description of study area

The study was conducted in Lilongwe rural, Malawi, sub-Saharan Africa (Figure 3) because it is where most of the ICT-based MIS initiatives are launched and promoted. The study adopted a cross-sectional survey as it allows collection of similar information from farmers in different extension planning areas (EPAs). Lilongwe district has 20 EPAs which are subdivided into sections. Agricultural Extension Development Officers (AEDOs) are assigned up to five sections and have lists of the farmers to serve.

4.2 | Sampling and data collection

A multistage sampling technique was used to select households. In the first stage, five EPAs were randomly selected, namely Chitekwere, Ukwe, Ming'ongo, Thawale, and Demela. Secondly, two sections were randomly sampled from each EPA. In the third stage, 199 households were systematically sampled from the respective AEDO's lists for questionnaire interviews. The required sample size was 196 and was calculated following the United Nations (2005) handbook for designing household survey samples, which is given as

$$n_h = \left(z^2\right)(r)(1-r)(f)(k)/(p)(\check{n})\left(e^2\right) \quad (1)$$

where n_h is the number of households, r is an estimate of users of mobile phones, f is the sample design effect, k is a multiplier to account for nonresponse, p is the proportion of the target population in the entire population, $\check{n}$ is the average household size, and e is the margin of error

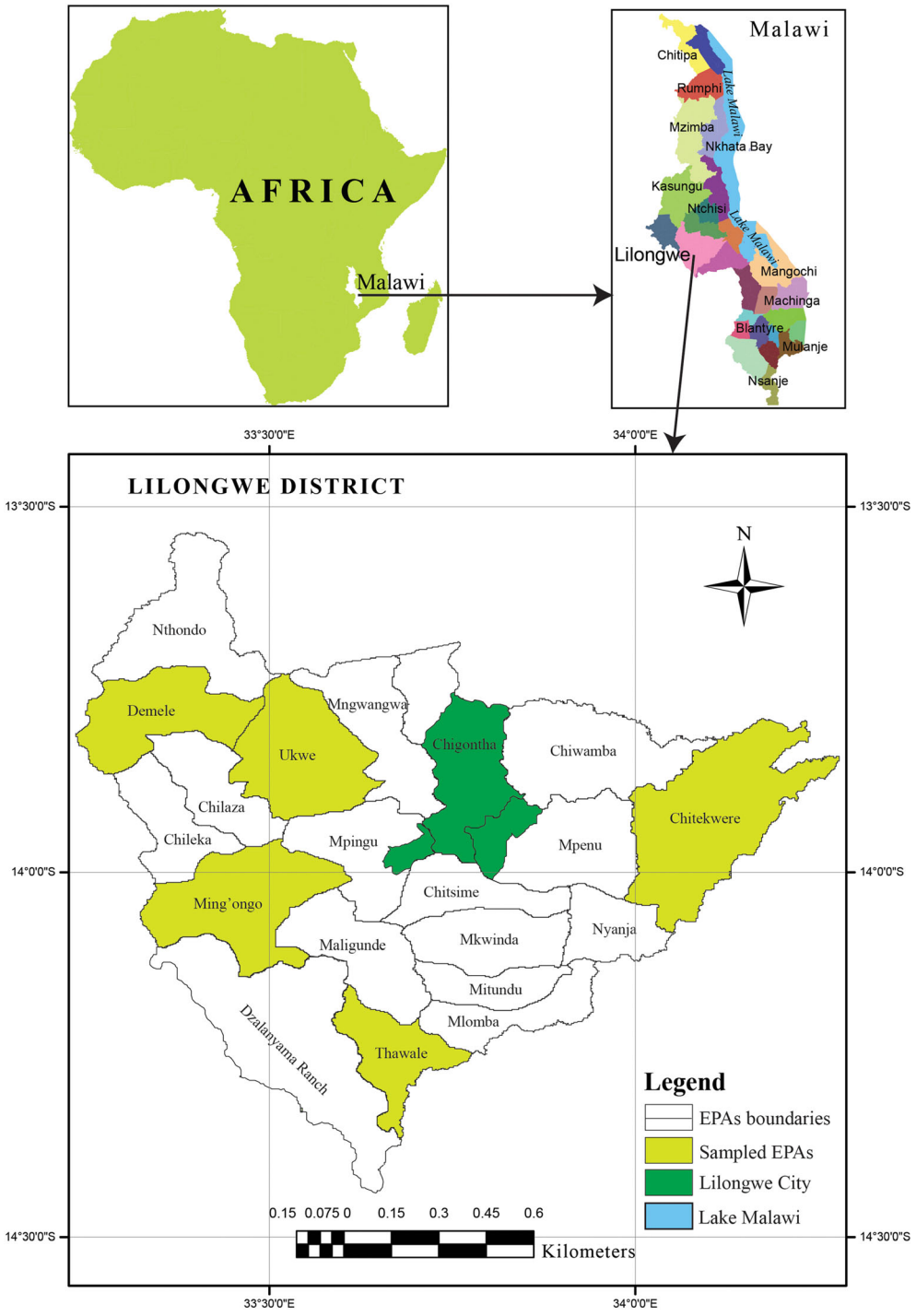

FIGURE 3 Map of Malawi and Lilongwe showing the sampled EPAs

to be tolerated. Recommended values for unknown constants are a *z*-statistic of 1.96 for the 95% level of confidence, a default value of 2.0 for f, and a value of 1.1 for k (United Nations, 2005). The Malawi National Statistics Office (2014) reports that the average household size $(\breve{n})$ in Malawi is six people. According to Kundhlande, Franzel, Simpson, and Gausi (2014), the proportion of the total population accounted for by smallholder farmers (p) is 80%, ie, 0.8. The National Statistics Office (2014) reveals that the overall proportion of Malawians owning mobile phones (r) is estimated to be 35%, ie, 0.35. The actual sample was inflated to 199 to minimize potential problems such as nonresponse and participants' denial to be interviewed.

During the survey, sampled households were interviewed by five experienced and well-trained enumerators using a structured and pretested questionnaire. The interview solicited data on farmers' socio-economic characteristics, their access to mobile-based MIS along with production of key crops, market participation, and institutional factors related to these matters.

Furthermore, focus group discussions were also organized to assess the relative importance of factors identified to influence smallholder farmers' adoption of the mobile phone-based MIS and participation in markets from their point of view. The application of methods of data analysis that are purely based on inferential statistics and qualitative approaches is useful in combining scientific and local knowledge because it allows analysts to uncover people's perceptions and values on specific issues of interest (Morgan, 2002).

In total, five discussions were organized, one per EPA. Ten participants were purposively selected from each EPA while ensuring the inclusion of both men and women within the sample and striking a good balance for other participants taking into account their age, marital status as well as education and income levels. The rule of thumb was to ensure inclusion of at least two male and two female farmers who are young adults (18-35 years) as well as three male and three female farmers who are above 35 years. Extension officers were consulted to identify participants with these credentials, and they guaranteed that farmers with different levels of education and income were included in the sample.

During the discussions, qualitative information was collated by a facilitator who introduced key issues for discussion, recorded and observed the discussions, probed, paused, reflected, and observed all nonverbal communication.

4.3 | Estimation procedures

Descriptive statistics, Chi-square analysis, *t*-test, and regression analysis were the most appropriate methods to analyse the quantitative data collected from the survey. These analyses were performed using STATA software version 14. However, a qualitative approach was necessary to evaluate qualitative information obtained from focus group discussions, although where quantification of responses was possible, percentages were computed and compared.

4.4 | Chi-square test of independence

The Chi-square test of independence was used to evaluate association between farmers' decision to participate in the maize market and specific categorical variables that were used to describe their socio-economic characteristics. Algebraically, the test is based on the following ratio:

$$\chi_k^2 = \Sigma \left(\frac{(O-E)^2}{E} \right) \tag{2}$$

where χ_k^2 is the Chi-square statistic with degrees of freedom k, O is the observed frequency of a variable of interest, and E is its expected frequency. The Chi-square test of independence, which was performed using the STATA software, tests the hypothesis that there is no association between two categorical variables. The decision to reject or fail to reject this hypothesis is based on the significance of the corresponding *P*-value (Gujarati, 2004). During the analysis, this test was adopted to test whether the decision to participate in maize markets or not was significantly associated with socio-economic characteristics of smallholder farmers. Note that this comparison was performed using the Kruskal-Wallis test (Chan & Walmsley, 1997) when variables with more than two categories were compared. The test was used to determine whether three or more independent groups were the same with respect to farmers' decisions to participate in maize markets.

4.5 | *t*-test for mean difference

The conventional *t*-test was adopted to test for mean difference in selected continuous variables between subscribers and nonsubscribers to the mobile phone-based MIS using the STATA software. It is worth noting that mobile phone-based MIS provide farmers with information they need to facilitate sale decisions and negotiations with traders (Wyche & Steinfield, 2015). Farmers with access to mobile phone-based MIS were expected to have enhanced bargaining power, receive higher prices, and sell more maize than those without access to this service (Katengeza et al., 2014). Moreover, farmers with access to mobile-based MIS could be better off in terms of productivity levels and sale of crops (Gani & Hossain, 2015; Nmadu et al., 2013). Therefore farm sizes, volumes of maize sold, and average maize prices for the categories of farmers were compared.

4.6 | Bivariate probit model

This study used a bivariate probit model to estimate the effect of mobile phone-based MIS on smallholder farmers' market decisions using the STATA software. Apart from the bivariate probit model, the study could have used propensity score matching (PSM) or difference in difference (DD) approaches to evaluate such effect (Khandker, Koolwal, & Samad, 2010). The PSM approach assumes a sizable common support or overlap in propensity scores across the samples of participants and nonparticipants (Khandker et al., 2010). However, the study used the simple random sampling approach to identify farmers for data collection implying that the overlap assumption was not met to validate the use of PSM. The DD could not be adopted because it measures differences in variables of interest between beneficiaries and nonbeneficiaries of a particular

intervention or treatment over years and it requires panel data (Khandker et al., 2010) that could neither be observed during the study period nor sourced from secondary sources. The bivariate probit model (BVPM) was employed as the outcome of interest was whether farmers' participation in the maize market was significantly influenced by their use of mobile phone-based MIS. This association entails two binary dependent variables that can be modelled using the BVPM. The model was adopted to estimate the joint probability of farmers' market participation and use of mobile phone-based MIS that was specified following Greene (2012):

$$I^* = X_1'\beta_1 + \varepsilon_1, \qquad I = 1 \text{ if } I^* > 0,\ 0 \text{ otherwise}, \tag{3}$$

$$M^* = X_2'\beta_2 + \gamma I + \varepsilon_2, \qquad M = 1 \text{ if } M^* > 0,\ 0 \text{ otherwise}, \tag{4}$$

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} | X_1, X_2 \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right] \tag{5}$$

where I^* and M^* are latent variables for use of mobile phone-based MIS and participation in maize markets, respectively, X_i denotes common covariates, ρ is the correlation coefficient, and ε_i is the error term with a unit variance and mean of zero.

The relationship can be expressed compactly as a joint probability as shown in Equations (6) and (7):

$$P(M = 1, I = 1) = P(I = \mathrm{M} | I = 1) P(I = 1) \tag{6}$$

$$P(M = 1, I = 1) = \boldsymbol{\Phi}\left(X_2'\beta_2 + \gamma, X_1'\beta_1, \rho\right) \tag{7}$$

where M is farmer's market participation, I is use of mobile phone-based MIS, $\boldsymbol{\Phi}$ is the cumulative distribution function of the bivariate standard normal distribution, β denotes the parameters that are estimated by maximum likelihood method, and X' is a vector of explanatory variables for market participation and use of mobile phone based-MIS.

Literature has established that farmers' market participation and adoption of technologies are mainly influenced by their socio-economic and demographic factors such as education level (Gani & Hossain, 2015; Magesa, Michael, & Ko, 2014), age along with sex of the main decision maker, farmers' resource endowments (Boughton et al., 2007) as well as access to agricultural markets (Fafchamps, Gabre-Madhin, & Minten, 2005; Jayne et al., 2010) and critical market development support services (Aker & Ksoll, 2016; Boateng, Hinson, Galadima, & Olumide, 2014). These variables shape farmers' market orientation (Fischer & Qaim, 2012), production (Musah et al., 2014), and their willingness to adopt new production and communication technologies (Boateng et al., 2014; Tadesse & Bahiigwa, 2015) such as improved seeds and mobile phones. In the empirical analysis, the authors focus on variables that are described in Table 1.

4.7 | Qualitative analysis

To facilitate quick analysis of the qualitative information collated during the focus group discussions, two techniques were used:

i. Listing participants' opinions and where possible ranking such opinions to gauge rank orders so as to facilitate quantitative analysis and;
ii. Coding the most significant opinions into key ideas and themes to ease discussion.

5 | RESULTS AND DISCUSSION

5.1 | Farmers' socio-economic characteristics

Table 1 gives a summary of farmers' socio-economic characteristics. This table indicates that farmers who decide to participate in the markets tend to be literate, own ICT devices such as a radio or mobile phone, produce relatively more maize, and have better access to extension services which is consistent with empirical evidence (Aker & Ksoll, 2016; Boateng et al., 2014) and the asset-based approach previously discussed in the conceptual framework. The table also indicates that many smallholder farmers (53% response) sold maize to local vendors owing to poor conditions of roads in their areas (57% response). These findings concur with both the TC approach, and most of the previous studies on maize marketing in Malawi which have established that TCs for trade of maize between isolated markets are generally high and potentially prohibitive for smallholder farmers' engagement (Fafchamps et al., 2005; Jayne et al., 2010).

TABLE 1 Socio-economic characteristics of the farmers

Variable Name		Frequency	Percent	Chi-Square or (Kruskal-Wallis) Statistic	*P*-Value
Sex of household head	Male	177	89	2.4452	.118
	Female	22	11		
Age of household head	18-35	64	32.16	0.206	.904
	36-59	93	46.73		
	60+	42	21.11		
Whether a household head is literate	Yes	178	89	3.9991**	.046
	No	21	11		
Marital status	Single	4	2	(3.3645)	.499
	Married	174	87		
	Widowed	10	5		
	Divorced	11	5.5		
Whether a household owns radio	Yes	90	45.23	8.0476**	.005
	No	109	54.23		
Whether a household owns mobile	Yes	100	50.25	3.9046**	.048
	No	99	49.75		
Whether maize yield is above 1000 kg	Yes	70	35.18	17.0095***	.000
	No	129	64.82		
Whether farm size is above 2.50 acre	Yes	77	38.89	14.606***	.000
	No	122	61.30		
Major market outlet for maize	Local market	9	4.52	(27.023)***	.000
	Vendor	106	53.26		
	Main trading centre	17	8.54		
	Company	36	18.09		
	Other buyers	31	15.57		
Condition of road	Tarmac road	36	18.09	6.14	.292
	No tarmac road but accessible by car throughout	114	57.29		
	Seasonally accessible by car	9	4.52		
	Seanally accessible by car but with difficult	6	3.02		
	Not accessible by car	34	17.08		
Subscribed to SMS alerts	Yes	21	10.55	0.132	.716
	No	178	89.45		
Access to marketing extension	Yes	50	25.13	4.594**	.032
	No	149	75.87		
Membership to farmers' group	Yes	106	53.27	13.134***	.000
	No	93	47.73		
Distance to market	Less than 5 km	140	70.35	14.482**	.002
	5-10 km	12	6.03		
	10-50 km	21	10.55		
	Above 50 km	26	13.07		
Maize variety grown	Local = 0	41	20.8	3.5272*	.060
	Improved = 1	156	79.19		
Education level of respondent	No formal eduaction	21	10.55	0.4520	.2734
	Low primary education	59	29.65		
	Primary education	84	42.21		
	College Education	22	11.06		
	Above collage education	13	6.53		
Primary purpose of growing maize	To meet food needs	162	82.23	46.356***	.000
	To earn income	1	0.51		
	To meet food demand and earn income	34	17.26		

***, ** and * means *P* significant at 1%, 5%, and 10% levels of significance, respectively.

The positive effects that education and asset endowment have on farmers' market participation have been reported (Gani & Hossain, 2015; Magesa et al., 2014) as relatively better off smallholder farmers tend to be more productive and hence more likely to produce a surplus for sale. The study found that above average maize yield and farm size are significantly associated with the probability to participate in maize markets. This association was anticipated and is consistent with theory and available evidence that higher yields ensure a marketable surplus (Musah et al., 2014). This is particularly true for maize in Malawi where smallholder farmers only participate in the market if they produced a surplus or are in immediate need for cash.

Moreover, the analysis predicts higher market participation for farmers who have adopted improved seeds, are members of farmer groups, and those located close to maize markets. These credentials are important in three ways: Membership to farmers' groups and/associations is an ideal means to enhance farmers' access to sources of vital information on production and marketing leading to enhanced abilities to bargain and collaborate in seizing emerging spatial and temporal marketing opportunities (Fischer & Qaim, 2012). The adoption of improved seeds has received a global appeal as one of the best ways for smallholder farmers to boost crop productivity. The prospect for smallholder farmers to participate in agricultural markets is likely to increase when they incur low transportation costs implying better prospects for those closer to markets than their counterparts in distant places. The findings are consistent with the TC approach. It is also worth noting that subsistence farming has been found to be associated with low market participation and is consistent with prior expectation.

Surprisingly, subscription to mobile phone-based MIS is not significantly associated with the probability to participate in the market. This is contrary to findings in Ghana where farmers who subscribed to the ESOKO MIS were more likely to participate in the market (Courtois & Subervie, 2014). However, similar findings were found in Ethiopia (Tadesse & Bahiigwa, 2015). This is likely due to huge differences in national mobile phone subscription rates between Malawi (37%) and Ghana (113%) and more similar rates with Ethiopia (31%) (Steinfield et al., 2015). Generally, mobile phone-based MIS have recorded weak impact in contexts where mobile phone penetration is low (Wyche & Steinfield, 2015). In addition, a majority of the farmers in Malawi sold their crop to vendors which may further explain why access to mobile phone based-MIS is not associated with market participation. In Malawi, vendors typically move around villages to buy produce from individual farmers who face transport constraints, and this spot procurement normally accords limited price negotiations. Consequently, if farmers do not have alternative options for markets, information will not influence their marketing outcomes (Fafchamps & Minten, 2012).

5.2 | Statistical test for mean differences

Results of tests for mean differences are presented in Table 2. These results show that farmers who subscribed to SMS market information alerts owned more land for agricultural production. The correlation between these two variables is expected as per the asset-based approach adopted for this study. A farmer who is wealthy is more likely to afford a mobile phone and the airtime needed to subscribe to the service (Boateng et al., 2014; Tadesse & Bahiigwa, 2015). In addition, the results indicate that the use of mobile phone-based MIS has no significant effect on the price farmers receive. While counter intuitive, this is consistent with the current context in Malawi where an ordinary smallholder farmer sells individually to vendors and is a price taker. Consequently, subscription to market information alone has an insignificant effect on farm gate prices.

5.3 | Effect of mobile phone-based MIS on farmers' participation in maize markets

The results from the BVPM estimation are presented in Table 3. The model was estimated with robust standard errors to correct for heteroscedasticity and other potential misspecification problems because the data used were from a cross-sectional survey (Musah et al., 2014). According to the rule of thumb, values of variance inflation factor (VIF) of greater than 10 are regarded as a signal for the existence of a severe multicollinearity problem in regression models (Gujarati, 2004, 2004). The model had a mean VIF of 3.28 implying that there was no severe multicollinearity.

Results indicate that yield and price significantly influenced market participation, echoing numerous studies which have established that farmers require surplus to participate in markets (Gani & Hossain, 2015; Nmadu et al., 2013). The results show that farmers who cultivate maize as a food and cash crop are more likely to participate in markets as they tend to produce more. The findings also indicate that farmers who are

TABLE 2 Mean values for selected variables of subscribers and non-subscribers to SMS market information alerts

	Whether Subcribed to SMS Market Information Alerts		Test for Mean Difference		
Variable	Yes (n = 21)	No (n = 178)	*t*-stat	*P*-value	Difference
Maize sold (kg)	336.19	212.58	0.934	.352	123.606
Farm size (acre)	2.9	2.3	1.741*	.083	0.671
Maize price (MKW)	76.67	75.51	0.056	.956	1.161

*means *P* significant at 10% level of significance.

1 USD = MKW726.

TABLE 3 Effect of mobile phone-based MIS on smallholder farmers' participation in maize markets

	Maximum Likelihood Estimates for Bivariate Probit Model			Marginal Effects for Joint Probability		
Variables	***Coef.***	***Std. err.***	***P-value***	***dy/dx***	***Std. err.***	***P-value***
Market participation						
Sex	−1.160**	0.514	0.043	−0.049	0.040	.228
Age (years)	0.003	0.013	0.819	0.0002	0.0006	.750
Farm size (acre)	0.077	0.128	0.548	0.011	0.008	.212
Primary purpose of farming	6.869***	0.583	0.000	0.259***	0.694	.000
Yield (kg)	0.0004**	0.0002	0.054	0.00003**	0.00001	.046
Distance	0.015**	0.006	0.020	0.0004	0.0004	.305
Variety of maize	0.402	0.568	0.479	0.025	0.031	.418
Price of maize	0.020***	0.002	0.000	0.0003	0.00002	.201
Access to market extension	0.835*	0.452	0.065	0.069**	0.028	.013
Low primary education	−0.579	0.438	0.187	−0.076**	0.037	.041
constant	−2.713	1.093	0.013			
Subscription to SMS price alerts						
Sex	−0.175	0.447	0.695			
Age (years)	0.002	0.007	0.826			
Farm size (acre)	0.105	0.073	0.153			
Primary purpose of farming	0.628	0.376	0.095			
Yield (kg)	0.0002	0.0001	0.097			
Distance	0.0001	0.005	0.990			
Variety of maize	0.169	0.325	0.601			
Price of maize	−0.003	0.001	0.067			
Access to market extension	0.555**	0.268	0.039			
Low primary education	−0.740**	0.314	0.019			
constant	−1.736	0.615	0.005			
rho	−0.131	0.386				
Number of obs = 197						
Wald $\chi^2(20) = 754.75$						
Prob $>\chi^2 = .0000$						
Log pseudolikelihood = −83.73658						
Wald test of rho = 0: $\chi^2(1) = 0.114$ Prob $>\chi^2 = 0.736$						

***, **, and * means *P* significant at 1%, 5%, and 10% levels of significance, respectively.

located near maize markets are relatively more educated, have better access to marketing extension services and are more likely to subscribe to SMS price alerts. These results are consistent with the Chi-square and *t*-test results that are presented in Tables 1 and 2, respectively. The higher probability for farmers with better access to market extension to participate in maize markets concurs with findings from a recent evaluation of a mobile phone-based information service called M'chikumbe in Malawi. Palmer and Darabian (2017) found that farmers accessed and trusted the M'chikumbe service more when AEDOs were engaged to raise their awareness of its importance.

The marginal effects for the joint probability suggest that farmers who are more educated, have better access to market-related extension services, cultivate maize as a food and cash crop, and produce higher yields. These farmers are also more likely to subscribe to SMS price alerts and participate in markets, which can be attributed to enhanced agricultural productivity associated with farmers' access to extension services. However, results reveal that there is insufficient evidence to suggest a significant effect of the existing mobile phone-based MIS on smallholder farmers' participation in maize markets, which is a novel result in the context of Malawi regarding the study topic. The Wald test of correlation, ie, rho (ρ), is insignificant implying that the average treatment effect is negligible. Tadesse and Bahiigwa (2015) found a similar effect in Ethiopia where mobile phones had weak effect on farmers marketing decisions, and Palmer and Darabian (2017) found that farmers' use of M'chikumbe in Malawi was limited and the provision of market price information did not bring about the anticipated effect.

5.4 | Findings from focus group discussions

Results from the focus group discussions that are presented here are meant to reveal opinions of smallholder farmers in Lilongwe with respect to factors that are considered when marketing maize. The current mobile phone-based MIS in Malawi entail users subscribing to SMS alerts although only 21 (10%) of the sampled farmers used this service whereas 116 (58%) received market information through radio programmes. The analysis reveals that many smallholder farmers preferred the radio because the aired programmes would supplement the price updates with production information and advice on collective marketing. To justify a higher preference for radio than other means of communication, one farmer stated that "radios don't need you to know how to read," which is consistent with the challenge of low literacy as an obstacle for farmers to access mobile phone-based MIS (Misaki et al., 2018). In regards to key factors that farmers considered when making marketing decisions, 50.8% mentioned convenience, 32.7% mentioned price offered, 25.6% mentioned immediate need for cash, and 12.6% mentioned transport costs. Therefore, smallholder farmers require price information, but this is not the only or necessarily the most significant determinant of their market participation. The information presented in Table 1 reveals that a significant majority (75%) of smallholder farmers had poor access to extension services, 61% had maize plots below 2.5 acres, and 64% harvested less than 1000 kg of maize. Accessing price information may not be a major concern for smallholder farmers with these characteristics because they hardly realize a surplus.

Moreover, results from the qualitative analysis revealed that low prices, unreliable markets, and vendors tampered weighing scales were the major limitations for smallholder farmers' participation in agricultural markets. These limitations create favourable conditions for continued exploitation of smallholder farmers by greedy traders as previously established by other scholars (Magesa et al., 2014; Nicholos-Ere, 2017). These findings are also consistent with research by Aker and Ksoll (2016) who report that other market failures might constrain households' production and consumption choices and their entitlements. Unexpectedly, lack of market information was not highlighted as a challenge in any of the focus group discussions. The lack of emphasis on poor access to market information by farmers concurs with Burrell and Oreglia (2015) who suggested that the notion that information which is critical to smallholder farmers' market participation is scarce and actively sought after is a potential misconception that is country and context specific. In addition, low price was equally a challenge for farmers who had access to and used mobile phone-based MIS and those who had no access implying that access to and use of price information alone may not suffice to promote farmers' market participation. Additionally, farmers identified erratic rainfall, pests and diseases, high input prices, and erosion that reduced soil fertility as other challenges faced in relation to market participation. This augments the evidence that smallholder farmers take into consideration their productivity levels and other shocks when making marketing decisions.

6 | CONCLUSION AND RECOMMENDATIONS

The main objective of this research was to determine the effect of the existing mobile phone-based MIS in Malawi on smallholder farmers' marketing decisions. The research found that the existing mobile phone-based MIS in Malawi which entail users subscribing to SMS price alerts have had insignificant effect on promoting smallholder farmers' participation in maize markets. Disseminating agricultural market information through a mobile phone-based MIS is likely to address the current untimeliness of the AMIS. However, it may not immediately promote smallholder farmers' market participation. Knowing prices is different from having the ability to take advantage of such information. An ordinary smallholder farmer in Malawi is often a price taker and lacks reliable transportation means to distant markets where prices may be better.

The findings suggest that channelling government resources towards improving extension services and increasing farmers' productivity are ideal ways to promote smallholder farmers' participation in maize markets. The findings further suggest the need to integrate radio and mobile phones in future designs of agricultural MIS and to provide farmers with information related to agricultural production in addition to market prices. These recommendations could be realized through better coordination of market access initiatives involving smallholder farmers, government departments, NGOs, mobile network operators, and media houses.

A pertinent area for further research is to assess how to adapt the existing mobile phone-based MIS initiatives to the context of Malawi so as to bring about significant effect. In addition, this study was limited to a single crop, and district, future studies may explore more crops and cover a wider geographical area.

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How to cite this article: Chikuni T, Kilima FTM. Smallholder farmers' market participation and mobile phone-based market information services in Lilongwe, Malawi. *E J Info Sys Dev Countries*. 2019;85:e12097. https://doi.org/10.1002/isd2.12097