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# Analysis of Rural Households' Mobile Phone Utilization Decision for Rural Innovation Services in Gomma Woreda, Southwest Ethiopia

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**Abstracts**
Mobile phones have already started functioning as more than just communications devices. It can promote innovation services for rural farmers. However, there are factors affecting mobile phone utilization for rural innovation services. The aim of this study was to analyze rural households' mobile phone utilization decision for rural innovation services in Gomma woreda, Southwest Ethiopia. Cross-sectional survey design was used for this study. Structured interview schedule, focus group discussion, key informant interview and personal observations were used as a method of data collection tools for this study. Multi-stage sampling technique was used for this study and data were collected by using both primary and secondary source of data from 188 sample household heads. Descriptive statistics including frequency and percentage and multivariate probit regression model were used for analyzing the data. The multivariate probit model was estimated jointly for marketing, agricultural, health and other mobile services. Wald test ($\chi2$ (56) = 158.12, p = 0.000) and the likelihood ratio test LR ($\chi2$ (6) = 30.4755, Prob>$\chi2$ = 0.000) is significant at the 1% level. The result revealed that education level, distance, frequency of extension contact, network problem and off/non-farm income were found to be significantly affecting rural farmers' mobile phone utilization decisions for rural innovation services. The correlation between using mobile for marketing and health service; marketing and other mobile services; and extension and other mobile service are negative and statistically significant. This indicates there was a competitive relationship of using mobile for marketing and health services, marketing and other mobile services and extension and other mobile service respectively. Therefore, rural mobile phone utilization for innovation services needed to be supported by stakeholders to solve the problems of mobile phone utilization in rural areas.
**Keywords**: Rural Innovation, Rural household, Mobile phone, Multivariate probit model, Utilization

## 1. Introduction

Agriculture is the backbone of most African countries and an important sector for the majority of the population of the countries (IFAD, 2013). The sector in Ethiopia is known for employing more than 80% of the total populations live in rural areas and is heavily dependent on rain-fed agriculture; this makes them extremely vulnerable to changes in weather conditions (Andersson *et al.,* 2011; Mohamed, 2017). However, the great potential of agriculture, the sector faces many challenges that delay its performance due to ineffective communication of agricultural information through mobile (Amir and Ewang, 2016).

The contribution of ICT in bringing about social and economic development has been well recognized globally (Sanga *et al.,* 2013). As mobile service penetration across Africa begins to exceed that of other core infrastructure, the mobile industry is beginning to have an increasingly significant impact on society (GSMA, 2011). According to World Bank (2011) the utilization of mobile phone provides market price information and agricultural extension services information directly to farmers in Ethiopia.

Furthermore, mobile phone is used to disseminate locally-generated and locally-relevant educational and health information, in order to target rural communities (Asheeta *et. al,* 2008). It has also a great contribution in health sector and it can support the rural people in health related services. It is also a crucial to facilitate data management; poor evidence based decision-making and clinical communication challenges on health related issues (Soar *et al*, 2012).

The expansion of rural electrification helps farmers to have an access to mobile telephone services in recent periods (Getaw and Godfrey, 2014), but there is evidence that most of the rural peoples lack the necessary knowledge, skills and attitude in using mobile phone for rural innovation services. There are also factors such as; low education level, very poor network coverage and unreliable power supplies that affect the rural farmers' mobile phone utilization decision for rural innovation services.

A little attempt has been made to study and understand the factors of mobile phone utilization decision of farmers for rural innovation services in Ethiopia as well as in the study area and its contribution for utilization of rural innovation services among smallholder farmers is being studied low in the study area. Despite the difference in their focus and area of study, the studies have identified of mobile phone utilization for rural innovation services is not well practiced for various reasons such as low education level, cost of mobile services and lack of infrastructure such as unreliable power supply and poor network connections.

The paper is aimed to describe general characteristics of rural households and analyze factors affecting the

 

rural households' decision of mobile phone utilization for rural innovation services in the study areas. Therefore, the findings of this study will be used in guiding policy makers, development planners, communication experts and researchers who are concerned to identify measures and create awareness about using mobile phone that will boost the effective utilization and expansion of mobile phone based services in the study area and elsewhere in the country.

The paper is organized as follows. Section 2 includes overview of mobile use, utilization of mobile phone for rural innovation services. Section 3 includes sample technique, the survey instrument, and the data collection and analysis. Section 4 is devoted to the research finding, econometric model result, while Section 5 includes discussion and conclusion.

## 2. Theoretical Background

### 2.1. Overview of Mobile Use

Mobile phone is one of the modern information technologies that interlink people with information services. Information could be shared between rural communities within the same country and even globally decreasingly isolation, flattening the learning curve and removing the need to reinvent the wheel for every type of community initiative: from education, finance, health, microfinance, private sector development, and many other arenas (Asheeta *et. al*, 2008). According to Qiang (2011) mobile applications can also promote agricultural and rural development, including better access to extension services; better market links and distribution networks; and better access to finance, including credit, insurance, payment methods and access to information about agricultural technologies and extension services. Also it raise farmers' incomes, making agricultural marketing more efficient, lowering information costs, reducing transport costs, and providing a platform to deliver services and innovate (Sife *et al.*, 2010).

According to Aker and Mbiti (2010) mobile phones can provide economic benefits to consumers and producers in Sub-Saharan Africa. First, mobile phones can improve access to and use of information, thereby reducing search costs, improving coordination among agents and increasing market efficiency. Second, this increased communication should improve firm's productive efficiency by allowing them to better manage their supply chains. Third, mobile phones create new jobs to address demand for mobile-related services, thereby providing income generating opportunities in rural and urban areas. Fourth, mobile phones can facilitate communication among social networks in response to shocks, thereby reducing households' exposure to risk. Finally, mobile phone-based applications and development projects sometimes known as m-development have the potential to facilitate the delivery of financial, agricultural, health and educational services.

Mobile phone is used to share information for target population. Currently it is spreading very fast in developing countries and most of the people are getting benefit from this technology with any difficulty and problem. In many rural areas of developing world, farmers are using mobile phones to obtain agricultural information (Aker and Fafchamp, 2011; and Gakuru *et al.,* 2009). But, communication received explicit attention in the context of studies on the adoption and diffusion of innovation that dominated the field of innovation studies in Ethiopia. However, a systematic rethinking of the role of communication in innovation processes is largely lacking (Mikinay, 2013).

Mobile phones also allow households to obtain information about potential shocks, allowing them to use such information to make planting and harvesting decisions, which can have important effects on yields. Despite of its contribution among improved communications members of a social network it can also affect social learning, which can in turn influence the rate of technology adoption, especially of cash crops (Conley and Udry, 2010).

### 2.2. Mobile Phone Utilization for Rural Innovation Services

Innovation involves the introduction of new products, services, production, new markets, and new organizational or market structures (Biancolino *et al*., 2013). The services which are transformed by mobile in rural areas are; information and experiences on agriculture, marketing of produce, and health is easily shared among rural dwellers for the improvement in their standard of living.

The utilization of mobile phone can eases the process of farmers' market information searching at a lower cost than other mechanisms (Jensen, 2007). With the help of mobile phones, farmers can decide on where, to whom, and when to sell their products and purchase inputs more easily than without mobile phones. Therefore, access to mobile phones can build farmers' confidence (reduce information uncertainty) on transactions, reduce marketing costs, and help them to receive higher prices. With respect to "marketing of produce", mobile telecommunications help deliver prices and trading information to both the farmers and other stakeholders in the agricultural sector (Aker, 2008).

The role of mobile phone in agriculture has never been in question in developing countries. Hence, the issue has migrated from whether to how. The idea of using mobile computing in agriculture (also known as M-Agriculture) is a new concept in North America, while M-Agriculture in the developing world has been known

 

and written about for almost a decade (Woodill and Udell, 2012). Agricultural information is often shared by the farmers via text messages and voice calls. Abraham (2007) reported that the results of using mobile phones for agricultural purposes are increased efficiency, increased yields, reduction in wastage and an overall positive effect on farmers' earning and livelihood. Agriculture is still the major source of employment in developing countries, despite the challenges farmers face due to climate change, hunger and a growing population (FAO, 2016). Mobile services aimed at agriculture, or mAgri, are for instance aimed at providing technical farming advice or location based weather updates and it can contribute to bridging the knowledge gap, thereby increasing agricultural production and profitability (GSMA, 2016).

M-Health can be defined as the use of mobile communications and network technologies for healthcare (Istepanian, 2004). This might include education and awareness, data collection (for public health or clinical domains), remote monitoring, communication and training for healthcare workers, disease surveillance and epidemic outbreak tracking (malaria, HIV/AIDS, TB, Avian Flu, and diabetes) as well as diagnostics and treatment support. Healthcare has adopted several innovations introduced by innovation system, among which stands out the electronic health record or electronic medical records, or the electronic patient record. This system provides a substantial number of benefits, which include better patient care, the centralization of information and the reduction in costs (Bowman, 2013).

In 2015, 400 million people did not have access to essential health services. In general, there are problems, both with the physical as well as financial access to and general lack of good quality health care. For example, there is an unequal spread of doctors around the world, leading to a lack of qualified professionals in the developing world. It is estimated that by 2035 there will be deficit of around 12.9 million skilled health workers. M-Health, which is the use of mobile services for the delivery of health services and information, has great potential contributed to overcoming these issues and transform the health sector. Especially in remote rural areas which are otherwise hard to reach, M-Health can be revolutionary in solving the pressing need for health care (Tomlinson, 2013 and West, 2015).

The mobile phones have provided new approaches and thinking to the farmers to get the information and it can facilitate social and business communications Getaw and Godfrey (2014). With the advent of mobile phones, many rural communities can easily communicate on social affairs such as funeral services, wedding ceremonies, and religious matters.

## 3. Research Methodology

### 3.1. The Sample Technique

The target population for this study was rural households who are using mobile phone for different agriculture related purpose, marketing services, health services and other mobile services. A multi-stage sampling procedure was used for this study. At the first stage Gomma woreda was selected purposively based on potential of agricultural production and marketing. At the second stage from 36 *kebeles* 3 *kebeles* were selected randomly. At the third stage a total of 188 households were selected by using simple random sampling technique based on proportionate to population size principle (PPS). This study applied a Yamane (1967) sample size formula to determine sample size.

### 3.2. Data Collection and Analysis Method

Concerning source of data, both primary and secondary sources were used in gathering valuable data. The needed type of information on demographic, socio-economic, institutional, and psychological variables and constraints of mobile phone use was collected through survey questionnaires, focus group discusion and key informants. Additionally, secondary data sources were collected from journals, published and unpublished academic documents.

Structured interview schedule, focus group discussions, key informant interviews and personal observation were used as a method of data collection. Structured interview schedule was designed to the sample respondents as tool of data collection.

Data were analyzed using descriptive statistics and econometric model. The collected data were organized, edited and analyzed using SPSS-20 and STATA-13 statistical packages. STATA-13 was used in finding out puts like Wald test, likelihood ratio, and P-value; and whereas other analysis where done using SPSS-20.

### 3.3. Regression Model

The multivariate probit model is a generalization of the probit model used to estimate several correlated binary outcomes jointly. It is one form of a correlated binary response regression model that simultaneously estimates the influence of independent variables on more than one dependent variables, and allows for the error terms to be freely correlated. The empirical specification of choice decision over the four groups of mobile based innovation services can be modeled in two ways, by either multinomial or multivariate regression analysis. One of the underlying assumptions of multinomial models is the independence of irrelevant alternatives that is error terms

 

of the choice equations are mutually exclusive (Greene, 2003). However, the choices among the innovation services are not mutually exclusive as farmers are using from more than one service at the same time and therefore the random error components of the innovation service may be correlated. Therefore, we consider using a multivariate model which allows for the possible contemporaneous correlation in the choice to access the four different innovation services simultaneously.

Empirically the model can be specified as follows:

$$Yi1 = X^{*}im1\beta 1 + \varepsilon i1$$
$$Yi2 = X^{*}im2\beta 2 + \varepsilon i2 \quad (1)$$
$$Yi3 = X^{*}im3\beta 1 + \varepsilon i3$$
$$Yi4 = X^{*}im4\beta 4 + \varepsilon i4$$

Where, $i$ = farmer id, $Yi1$ = 1, if farmer use mobile for marketing services (0 otherwise), otherwise), $Yi2$ = 1, if farmer use mobile for agricultural extension services (0 otherwise), $Yi3$ = 1, if farmer use mobile for health services (0 otherwise), $Yi4$ = 1, if farmer use mobile for other mobile services such as; news services, as torch and calculator services (0 otherwise), $X'i$ = Vector of factors affecting mobile phone utilization decision for rural innovation services, $\beta m$ = Vector of unknown parameters ($m$ =1, 2, 3, 4), and $\varepsilon$ = is the error term.

$$Y^{*}im = X^{*}im\,\beta m + \varepsilon im \qquad m=1, 2...4 \quad (2)$$

Where $Yim$ ($m$ =1, … ,4) represent the four different innovation services used by the ith farmer ($i$ = 1, … ,188), $X^{*}im$ is a $1 \times k$ vector of observed variables that affect the choice decision of farmer βm is a $k \times 1$ vector of unknown parameters (to be estimated), and $\varepsilon im$ is the unobserved error term.

Thus, the econometric approach for this study is by using the indicator function; the unobserved preferences in Eq. (3) translate into the observed binary outcome equation for each choice as follows

$$Yim = 1 \text{ if } Y^{*}im > 0 \qquad i = (\text{m= Y1, Y2, Y3, Y4}) \quad (3)$$
$$0 \text{ otherwise}$$

And $\varepsilon im$, $m=1, 2,..4$ are distributed multivariate normal each with mean 0 and a variance-covariance matrix V, where V has 1 on the leading diagonal, and correlations Rho (ρ) $\rho kj=\rho jk$ as off diagonal elements:

$$V = \begin{bmatrix} 1 & \rho 12 & \rho 13 & \rho 14 \\ \rho 21 & 1 & \rho 23 & \rho 24 \\ \rho 31 & \rho 32 & 1 & \rho 34 \\ \rho 41 & \rho 42 & \rho 43 & 1 \end{bmatrix} \quad (4)$$

The multivariate probit model was estimated by simulated maximum likelihood. The log-likelihood function for a sample of $N$ independent observations is given by

$$\sum_{i=1}^{N} wi \log \Phi m\,(\mu; \Omega) \quad (5)$$

Where is $wi$ an optional weight for observation =1…N and ($\Phi m$) is the multivariate standard normal distribution with arguments $\mu i$ and Ω where with $\mu i = (Kim\ Xim)$ with $kik=2yik-1$ for each 1k=1…m Matrix Ω would have constituent elements where $\Omega ik$.

$\Omega i=1$ for i=1… m

$$\Omega 21 = \Omega 12 = ki1ki2\rho 21 \quad (6)$$
$$\Omega 31 = \Omega 13 = ki3ki1\rho 31$$
$$\Omega ik = \Omega ki = k_{im}k_{im-1}\rho_{mm-1} \quad (7)$$

Table 1: Variables included in the regression models.

| | | Independent variables | Type |
|---|---|---|---|
| 1 | AGE | Age of household in years | Continuous |
| 2 | SEX | Sex of household | Dummy, 0=female, 1= male |
| 3 | EDU | Education level of household in year of Schooling | Categorical |
| 4 | LAND | Total land holding size of household in hectare | Continuous |
| 5 | ACRDT | Access to credit services | Dummy, 1 is access to credit 0 otherwise |
| 6 | ACCPS | Access to power supply | Dummy, 1 if yes and 0 otherwise |
| 7 | FRQEX | Frequency of extension contact in number of days per year | Continuous |
| 8 | FARM | Total farm income of households in ETB | Continuous |
| 9 | ONFI | Off and non-farm income of households in ETB | Continuous |
| 10 | ACSN | Suitable network connection | Dummy, 1 is access to network 0 otherwise |
| 11 | SOCOP | Access to social participation | Dummy, 1 if yes and 0 otherwise |
| 12 | MSCHAR | Cost of mobile services in ETB | Continuous |
| 13 | DISTA | Distance to market in Km | Continuous |
| 14 | PERCEP | Perception towards mobile use in Likert scale | Categorical |

 

## 4. Research Findings

### 4.1. General Characteristics of Sample Respondents

Table 2 shows the general characteristics of rural farmers in Gomma woreda, Southwest Ethiopia. The Table reveals that the respondents' mean age was 42.51 years. This shows a high level of literacy (86.7%), among the respondents. The average yearly income from farm and off/non-farm was 12708.59 and 1446.03 ETB. The respondents' average land size was 1.69 ha and average cost for mobile services was 69.68 and the average distance from the nearest town was 3.74 Km in the study area.

Table 2 General characteristic of rural farmers

| Category | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Age | 22 | 70 | 42.51 | 10.45 |
| Total land size | 0.13 | 10 | 1.69 | 1.61 |
| Farm income | 500.00 | 40900 | 12708.59 | 9171.94 |
| Off/Non-farm income | 0 | 18800 | 1446.03 | 3335.68 |
| Mobile service charge | 10 | 300 | 69.68 | 59.77 |
| Distance | 0.5 | 11.5 | 3.74 | 2.07 |

About 95.2% of the respondents were males while 4.8% were females; and 62% of the respondents were married while 38% were single. About 25.5%, 17.6%, 22.9% and 22.3% of the sample household heads were illiterate, read and write, Grade (1-4) and Grade (5-8) respectively. However, 10.1% attended Grade (9-12), and whereas the smallest proportion 1.6% above grade 12. About 41% of the sample respondents reported that they had not contact with extension agents through mobile phone. The survey result show that about 11.7%, 29.3%, 8%, and 10% were contact extension agents by their mobile in every week, twice in a month, once in a year and twice in a year respectively (Table 3).

About 50%, 25.5%, 14.4%, 9% and 1% respectively on the effectiveness mobile phone utilization for rural innovation services (Table 3). Finance is the crucial element starting from land preparation up to the marketing of the product. As shown in table 3, only 54.3% of sample respondents had access to credit and 45.7% had no access to credit in the study area in 2016/17. From the institutional factors, access to power supply is the most important factor that enables rural farmers to use mobile for different rural innovation services. As depicts in table 3, 83.5% of sampled households had access to power supply in the nearby areas to recharge their mobile and 16.5% had not got access to power supply in nearby areas in the study area.

There is an access to network to use mobile phone for different rural innovation services in the study area, but suitable network connection in the area was a problem for rural households to use mobile phone for different services. About 55.9% of sample respondents had access to suitable network while 44.1% of the sampled respondents had not access to suitable network and about 74.5% of sample respondents had participated in social organization of while 25.5% of them had not participated in social organization (such as Farmers' association/cooperatives, Iddir and Ikub) in the study area (Table 3). The result shows that about 50%, 25.5%, 14.4%, 9%, and 1.1% had strongly-agree, agree, neutral, dis-agree and strongly dis-agree respectively to perceived that mobile phone was an important technology to access rural innovation services (Table 3).about in the study area.

 

Table 3: Demographic, institutional and psychological variables of respondents (Dummy and categorical variables)

| Characteristics | | Frequency | Percent |
|---|---|---|---|
| Sex | Male | 179 | 95.2 |
| | Female | 9 | 4.8 |
| Education level | Illiterate | 48 | 25.5 |
| | Read and Write | 33 | 17.6 |
| | Grade (1-4) | 43 | 22.9 |
| | Grade (5-8) | 42 | 22.3 |
| | Grade (9-12) | 19 | 10.1 |
| | Above 12 | 3 | 1.6 |
| Frequency of extension contact | Not applicable | 77 | 41.0 |
| | Every day | 0 | 0 |
| | Every week | 22 | 11.7 |
| | Twice in a month | 55 | 29.3 |
| | Once in a year | 15 | 8 |
| | Twice in a year | 19 | 10.1 |
| Perception | Strongly-agree | 94 | 50 |
| | Agree | 48 | 25.5 |
| | Neutral | 27 | 14.4 |
| | Dis agree | 17 | 9 |
| | Strongly dis agree | 2 | 1.1 |
| Credit access | No | 86 | 45.7 |
| | Yes | 102 | 54.3 |
| Power supply | No | 31 | 16.5 |
| | Yes | 157 | 83.5 |
| Suitable network connection | No | 83 | 44.1 |
| | Yes | 105 | 55.9 |
| Social participation | No | 48 | 25.5 |
| | Yes | 140 | 74.5 |

**4.2. Regression Analysis**

The Wald test ($\chi2(56) = 158.12$, $p = 0.000$) is significant at the 1% level, which indicates that the subset of coefficients of the model is jointly significant and that the explanatory power of the factors included in the model is satisfactory; thus, the MVP model fits the data reasonably well.

Likewise, the model is significant because the null that choice decision of the four innovation services is independent was rejected at 1% significance level (Appendix table 1). The results of the likelihood ratio test in the model LR ($\chi2$ (6) =30.4755, Prob >$\chi2$=0.0000) indicates the null that the independence between mobile phone utilization for rural innovation services (rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0) at 1% significance level. Therefore, the null hypothesis that all the ρ (Rho) values are jointly equal to 0 is rejected, indicating the goodness-of-fit of the model. Hence, there are correlations in using mobile for innovation service among farmers, which are reflected in the likelihood ratio statistics (Appendix table 1).

There are significant joint correlations for three estimated coefficients across the equations in the models (Appendix table 1). This verifies that separate estimation of using mobile for rural innovation services is biased, and the mobile phone utilization for rural innovation services of the four innovation services are interdependent household decisions. There are differences in using of mobile for rural innovation services among rural households, which are reflected in the likelihood ratio statistics of estimated correlation matrix. Separately considered, the ρ (Rho) values (ρij) indicate the degree of correlation between each pair of dependent variables. The ρ31 (correlation between using mobile for marketing and health services) are negative and statistically significant at the 10% probability level, indicating a competitive relationship of using mobile for marketing and health services, ρ41 (correlation between using mobile for marketing and other mobile services such as for news, as torch and calculator services) are negative and statistically significant at the 1% probability level, indicating a competitive relationship of using mobile for marketing and other mobile services while ρ42 (correlation between using mobile for agricultural extension and other mobile services such as for news, as torch and calculator services) are negatively interdependent and significant at the 5% probability levels, indicating a competitive relationship of extension and other mobile services (Appendix table 1).

The marginal success probability for each innovation services and the simulation results indicate that the probability that mobile phone utilization for marketing services, agricultural services, health services, and other

 

mobile services of rural innovation services were 71.4%, 68.6%, 62.6%, and 69.4% respectively (Table 4). The likelihood of utilization of mobile for health services is relatively low (62.6%) as compared to the probability of utilization of mobile for marketing services (71.4%), agricultural services (68.6%) and other mobile services (69.4%). This is a good evidence to suggest that using mobile for health services is a challenge.

Table 4: Simulation results of probability of mobile phone utilization for each rural innovation services.

| Variable | Obs | Mean | Std. Dev. |
|---|---|---|---|
| innov1 | 188 | 0.7145 | 0.3824 |
| innov2 | 188 | 0.6861 | 0.3909 |
| innov3 | 188 | 0.6262 | 0.4249 |
| innov4 | 188 | 0.6941 | 0.2123 |

Innov1=marketing services, Innov2=agricultural services, Innov3=health services, Innov4=other mobile services, Std. Dev=standard deviation, Min=minimum, Max=maximum

The joint probabilities of success or failure of mobile phone utilization of the four innovation services suggest that households are less likely to fail to jointly use the four innovation services. The likelihood of households to jointly use the four innovation services simultaneously is 34.5%, while their failure to jointly use is nearly 2.9% (Table 5).

Table 5: The joint probabilities of success or failure of mobile phone utilization for rural innovation services.

| Variable | Obs | Mean | Std. Dev. |
|---|---|---|---|
| innopro1s | 188 | 0.3531 | 0.3490 |
| innopro0s | 188 | 0.0295 | 0.0773 |

Innopro1s=probability of success, innopro0s=probability of failureStd. Dev=standard deviation, Min=minimum, Max=maximum.

Based on result of the MVP model in Table 6 below, some of the explanatory variables were significant to affect mobile phone utilization for particular rural innovation services and it can be insignificant for the other rural innovation services. Thus, the multivariate probit analysis result reveals that the utilization of each rural innovation service is influenced by the same or different factors at different or same level of significance.

Table 6: Multivariate probit estimations for determinates of mobile phone utilization for rural innovation services.

| Variables | MFMARK | MFAGEX | MFHEAL | MOTHERS |
|---|---|---|---|---|
| | Coeff(Se) | Coeff(Se) | Coeff(Se) | Coeff(Se) |
| AGE | -0.0776***(0.029) | 0.0062(0.025) | -0.0231(0.024) | -0.0226(0.015) |
| SEX | 1.3987(1.531) | 0.1976(1.486) | -1.0702(0.912) | 0.7022*(0.383) |
| EDUC | 0.5248*(0.296) | 0.5405**(0.255) | 0.6199**(0.254) | 0.4454***(0.141) |
| DISTA | -0.2667**(0.125) | -0.0643(0.095) | 0.1714*(0.093) | 0.0755(0.057) |
| DGCRDT | 0.1178(0.416) | 0.2481(0.385) | 1.654533 ***(0.364) | -0.0811(0.235) |
| LAND | -0.0453(0.140) | 0.0559(0.096) | 0.1072(0.138) | -0.0041(0.075) |
| FRQEX | -0.4642**(0.217) | 0.5583***(0.149) | -0.1885(0.163) | -0.0084(0.084) |
| FARM | 0.0000(0.000) | 0.0000(0.000) | -0.0000(0.000) | -9.64e-06(0.000) |
| OFFN | 0.0003***(0.000) | -7.96e-06(0.000) | 4.00e-06(0.000) | -0.0000**(0.000) |
| ACCNET | 4.090967 ***(1.089) | 1.3674**(0.538) | 1.838784***(0.553) | -1.5179***(0.359) |
| MCHAR | -0.0174***(0.006) | 0.001118(0.004) | 0.0054(0.004) | 0.0034(0.002) |
| PERCEP | -0.0206(0.415) | -0.1405(0.402) | 0.2947(0.413) | 0.3820(0.263) |
| ACCPS | -0.4634(0.541) | -0.2170(0.563) | -0.2585(0.564) | 0.4279(0.288) |
| SOCORG | -0.6797(0.462) | 0.0815(0.411) | 0.5040(0.471) | -0.4319(0.268) |
| _cons | 3.741*(2.179) | -2.4462(2.253) | -1.5487(1.812) | -0.0600(1.048) |

Coeff=coefficient, Se=standard errors, Wald $\chi2(56)$= 158.12, Log likelihood = -190.13073, Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: where 1, 2,3 and 4 stands for Marketing services, Agricultural services, Health services and other mobile services (news services, as torch and calculator services) respectively, $\chi2(6)$= 30.4755 Prob >$\chi2$=0.0000, ***, **, and * are statistically significant at < or = 1%, 5% and 10% respectively.

## 5. Discussion and Conclusion

Mobile phone, one of the modern technologies for developing countries, that is used for accessing different rural innovation services. It has the potential to allow rural households to get marketing services, agricultural extension services, health services and other mobile services timely.

As identifying factors affecting mobile phone utilization decision of framers' for rural innovation services; sex, education, and credit access affects the likelihood of mobile phone utilization for different rural innovation

 

services significantly and positively. Off/non-farm activity has a positive relation with likelihood of using mobile phone marketing and negative relation with other mobile services. Suitable network connection is positively associated with likelihood of using mobile phone for marketing services, agricultural extension services, and health services. But it is negatively associated with likelihood of using mobile phone. Cost of mobile services is negatively associated with likelihood of using mobile for marketing service and distance is also negatively associated with likelihood of marketing services via mobile and positively associated with likelihood of health services via mobile. It reflects that the household located far away from the nearest market center faces difficulty to get information access on product price and they cannot get mobile card in nearby place. Further critical research was needed to explore the mobile phone utilization for rural innovation services in situated practices in the field, in total providing a richer evidence base for research and development policy.

Age of households has a negative relation with likelihood of mobile phone utilization for marketing services at less than 1% significance level. This implies that when the age of farmers increase the probability of using mobile phone for marketing services decrease. The negative and significant result reflects that the aged farmers most of the times come up with their previous knowledge and they are not eager to adopt new and updated information. This finding is in line with the result of Getaw and Godfrey (2014) who states that younger households are more likely to use mobile phones for information searching than older house-holds in Ethiopia.

The sex has a positive relation with likelihood of mobile phone utilization for other services such as news, as torch and calculator services at less than 10% level of significance. The positive and significant result shows that male and female were equally uses mobile phone for news, torch and calculator services. This result is consistent with the study by Babar *et al*., (2008) who find that mobiles phones controlled by other family members, especially husbands, were inaccessible to the women for accessing information.

The education has a positive relation with likelihood of mobile phone utilization for marketing at less than 10% level of significance. The positive and significant result implies that households who are composed of educated use mobile phone for marketing services. This result is consistent with study by Katengeza *et al.,* (2010) who states that education allows farmers to strike better price deals within their existing trading relationships, and to make better choices about where to sell their produce through mobile in Malawi.

The education has a positive relation with likelihood of mobile phone utilization for agricultural extension services at less than 5% level of significance. The positive and significant result shows that the farmers who are composed of educated uses mobile for agricultural extension services. The positive sign of year of education implies that as year of education increases, the probability of use mobile phone also increases. This is in line with the finding of Yaredo and Adan (2016) in Somalia region of Ethiopia who found that education was affect mobile phone use of farmers positively and significantly at 10 percent probability level for agricultural extension services.

The education has a positive relation with likelihood of mobile phone utilization for health extension services at less than 5% level of significance. The positive and significant result shows that households who are composed of educated uses mobile for health extension services. This result is consistent with study by Asenso-Okyere and Mekonnen (2012) that showed education was influences farmers to use mobile phone for health services to remote areas in Africa.

The education has a positive relation with likelihood of mobile phone utilization for other mobile services at less than 1% level of significance. The positive and significant result implies that farmers who are composed of education uses mobile for news, as torch and calculator services rather than non-educated farmers. This result is similar to the finding of Sekabira (2012) that confirm education has the potential to increase the probability of using mobile phone for news services by individuals in Uganda.

The distance from the nearest market center is negatively associated with likelihood of mobile phone utilization for marketing services at less than 5% level of significance. The negative and significant result implies that households who are far apart from nearby markets cannot get mobile services. When a distance from the nearest town increases, the chance of the farmers to get and use mobile phones decreases. This result is similar to the finding of Tadesse and Shively (2013) that confirms farmers who are closer to markets had better access to information sources through mobile from traders and institutions in the market than distant farmers, which has been proved in previous studies in Ethiopia.

The distance from the nearest market center is positively associated with likelihood of mobile phone utilization for health services at 5% level of significance. The positive and significant result shows that when the distance increases, the probability of using mobile for health services also increases. The farmers who are far from the health center uses mobile phone for health services rather than others. This study is in line with Molla and Ndemo (2017) who found that farmers in the nearest of health center contact health experts face to face rather than contacting in their phone in Fogera district of South Gondar.

Frequency of extension contact has a negative relation with likelihood of mobile phone utilization for marketing services at less than 5% level of significance. The negative and significant result shows that farmer does not communicate with extension agents in their mobile phone for marketing information services. This

 

result is inconsistent with study by Mtega (2012) in Tanzania who found that frequency of extension contact is a positive relationship with the access to and usage of information among rural communities.

Frequency of extension contact has a positive relation with likelihood of mobile phone utilization for agricultural extension services at 5% level of significance. The positive and significant result shows that the extension contacts play a great role in the transfer and diffusion of technology that strengthen the agricultural extension system. This result is consistent with study by Qiang *et.al,* (2012) who confirm that frequency of extension contact with mobile phone is used to transfer better access to extension services.

Off/non-farm activity increases the confidence level of farmer's to deal with technology and increases the risk taking capability and it has a positive relation with likelihood of mobile phone utilization for marketing at less than 1% level of significance. The positive and significant result implies that households who have got income from off/non-farm activity uses mobile for marketing activities. This result is similar to the finding of Abu *et.al,* (2017) that states using mobile phones for marketing among farmers have played positive impact in their income and productivity in Bangladesh.

Off/non-farm activity has a negative relation with likelihood of mobile phone utilization for other mobile services at less than 5% level of significance. The negative and significant result implies that households who have income from off/non-farm activity does not uses mobile for news, as torch and calculator services. This result is inconsistent with the study of Molla and Ndemo (2017) who confirms that the effect of income was statically significant and has positive effects on mobile phone use for accessing new information.

Suitable network connection is positively associated with likelihood of mobile phone utilization for marketing services at less than 1% level of significance. The positive and significant result shows that households gets marketing services timely with in their mobile when there is a network connection. This result is consistent with study by Asheeta *et.al,* (2008) who confirm that growing rural networks in many developing countries influences farmers for searching market information.

Suitable network connection is positively associated with likelihood of mobile phone utilization for agricultural extension services at 5% level of significance. The positive and significant result shows that availability of mobile network connections influences households to use mobile for acquiring different agricultural extension services. This result is consistent with the study by Olatokun (2013) who confirm that mobile telephone networks found that the probability of subscribing to the telephone networks was positively correlated with income.

Suitable network connection is positively associated with likelihood of mobile phone utilization for health services positively at 1% level of significance. The positive and significant result implies that availability of mobile network connection influences households to use mobile phone for getting information from the health expert timely. This result is consistent with the study by Njelekela and Sanga (2015) who points out that lack of telecommunication networks is a factor affecting the use of telecentre for needed purpose in Tanzania.

Suitable network connection is negatively associated with likelihood of mobile phone utilization for other mobile services at 1% level of significance. The negative and significant result shows even if there is network connection farmer did not use their mobile phone for other mobile service. It reflects that suitable network connection does not influence farmers to use other mobile services such as news. This implies that most of the rural farmers were used mobile phone for other purposes rather than using for other mobile services. This result is consistent with the study by Asheeta *et.al,* (2008) who states that growing rural networks in many developing countries influences farmers for searching information.

Cost of mobile services is negatively associated with likelihood of mobile phone utilization for marketing service at less than 1% level of significance. The negative and significant result shows that farmers do not use mobile phone for marketing due to high cost of mobile phone service provision like calling, and messaging. This result is consistent with the study by Njelekela and Sanga (2015) who points out costs of using services is a factor that affecting the use of telecentre for marketing services in Tanzania.

The credit access has a positive relation with likelihood of mobile phone utilization for health extension services at less than 1% level of significance. The positive and significant result shows that the access to credit was influences farmers to use mobile phones for health services. This result is similar to the finding of Molla and Ndemo (2017) who confirm that access to credit had positive and significant influence on mobile phone use at 1% probability level in Fogera district of South Gondar.

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## Appendix Table 1: Multivariate probit model results

Multivariate probit (SML, # draws = 5) Number of obs= 188
Wald chi2(56)= 158.12
Log likelihood = -190.13073 Prob > chi2= 0.0000

| | Coef. | Std. Err. | z | P>z | [95% Conf. Interval] |
|---|---|---|---|---|---|
| MFMARK | | | | | |
| AGE | -.0776079 | .0289081 | -2.68 | 0.007 | -.1342668 -.020949 |
| SEX | 1.398798 | 1.531227 | 0.91 | 0.361 | -1.602353 4.399949 |
| EDUC | .5248927 | .2958143 | 1.77 | 0.076 | -.0548927 1.104678 |
| DISTA | -.2667864 | .1248767 | -2.14 | 0.033 | -.5115402 -.0220326 |
| DGCRDT | .1178227 | .4162646 | 0.28 | 0.777 | -.698041 .9336864 |
| LAND | -.0453311 | .1401911 | -0.32 | 0.746 | -.3201005 .2294384 |
| FRQEX | -.4642005 | .2170083 | -2.14 | 0.032 | -.8895289 -.038872 |
| FARM | .0000189 | .0000392 | 0.48 | 0.629 | -.0000579 .0000958 |
| OFFN | .0003282 | .0001182 | 2.78 | 0.005 | .0000965 .0005599 |
| ACCNET | 4.090967 | 1.088896 | 3.76 | 0.000 | 1.956771 6.225163 |
| MCHAR | -.0174104 | .0062314 | -2.79 | 0.005 | -.0296237 -.0051972 |
| PERCEP | -.0206157 | .4152184 | -0.05 | 0.960 | -.8344289 .7931974 |
| ACCPS | -.4634042 | .5407759 | -0.86 | 0.391 | -1.523306 .5964972 |
| SOCORG | -.6797835 | .4621292 | -1.47 | 0.141 | -1.58554 .225973 |
| _cons | 3.741597 | 2.17898 | 1.72 | 0.086 | -.5291249 8.012319 |
| MFAGEX | | | | | |
| AGE | .006213 | .0245044 | 0.25 | 0.800 | -.0418148 .0542408 |
| SEX | .1976122 | 1.486169 | 0.13 | 0.894 | -2.715225 3.11045 |
| EDUC | .5405689 | .2546911 | 2.12 | 0.034 | .0413834 1.039754 |
| DISTA | -.0643806 | .0950394 | -0.68 | 0.498 | -.2506544 .1218931 |
| DGCRDT | .2481486 | .3859516 | 0.64 | 0.520 | -.5083025 1.0046 |
| LAND | .05599 | .096178 | 0.58 | 0.560 | -.1325154 .2444954 |
| FRQEX | .5583617 | .1487613 | 3.75 | 0.000 | .266795 .8499284 |
| FARM | .0000357 | .0000267 | 1.34 | 0.180 | -.0000165 .0000879 |
| OFFN | -7.96e-06 | .0000725 | -0.11 | 0.913 | -.00015 .0001341 |
| ACCNET | 1.367442 | .5377661 | 2.54 | 0.011 | .31344 2.421445 |
| MCHAR | .001118 | .0041526 | 0.27 | 0.788 | -.0070209 .0092569 |
| PERCEP | -.1405479 | .4022435 | -0.35 | 0.727 | -.9289308 .6478349 |
| ACCPS | -.2170634 | .5631445 | -0.39 | 0.700 | -1.320806 .8866795 |
| SOCORG | .0815886 | .4109143 | 0.20 | 0.843 | -.7237887 .886966 |
| _cons | -2.446291 | 2.252916 | -1.09 | 0.278 | -6.861926 1.969345 |
| MFHEAL | | | | | |
| AGE | -.0231061 | .0244543 | -0.94 | 0.345 | -.0710357 .0248235 |
| SEX | -1.070274 | .9116382 | -1.17 | 0.240 | -2.857052 .7165038 |
| EDUC | .6199842 | .2535292 | 2.45 | 0.014 | .123076 1.116892 |
| DISTA | .171464 | .092529 | 1.85 | 0.064 | -.0098896 .3528175 |
| DGCRDT | 1.654533 | .3637393 | 4.55 | 0.000 | .9416167 2.367449 |
| LAND | .1072368 | .1379959 | 0.78 | 0.437 | -.1632302 .3777039 |
| FRQEX | -.188579 | .162671 | -1.16 | 0.246 | -.5074083 .1302504 |
| FARM | -.000041 | .0000262 | -1.56 | 0.118 | -.0000924 .0000104 |
| OFFN | 4.00e-06 | .0000592 | 0.07 | 0.946 | -.000112 .00012 |
| ACCNET | 1.838784 | .5526909 | 3.33 | 0.001 | .7555295 2.922038 |
| MCHAR | .0054809 | .0043137 | 1.27 | 0.204 | -.0029738 .0139357 |
| PERCEP | .2947142 | .4127304 | 0.71 | 0.475 | -.5142226 1.103651 |
| ACCPS | -.2585183 | .5632977 | -0.46 | 0.646 | -1.362561 .8455248 |
| SOCORG | .5040122 | .4713573 | 1.07 | 0.285 | -.4198311 1.427856 |
| _cons | -1.548713 | 1.812913 | -0.85 | 0.393 | -5.101958 2.004531 |
| MOTHERS | | | | | |
| AGE | -.0226997 | .0151973 | -1.49 | 0.135 | -.0524858 .0070864 |
| SEX | .7022043 | .3832358 | 1.83 | 0.067 | -.048924 1.453333 |
| EDUC | .4454729 | .1407276 | 3.17 | 0.002 | .1696517 .721294 |
| DISTA | .0755708 | .0571053 | 1.32 | 0.186 | -.0363535 .187495 |
| DGCRDT | -.0811647 | .2351948 | -0.35 | 0.730 | -.5421381 .3798086 |
| LAND | -.0041219 | .0745097 | -0.06 | 0.956 | -.1501581 .1419143 |
| FRQEX | -.0084729 | .0844683 | -0.10 | 0.920 | -.1740278 .157082 |
| FARM | -9.64e-06 | .0000158 | -0.61 | 0.542 | -.0000406 .0000214 |
| OFFN | -.0000759 | .0000346 | -2.19 | 0.028 | -.0001436 -8.11e-06 |
| ACCNET | -1.517975 | .3585367 | -4.23 | 0.000 | -2.220694 -.8152557 |
| MCHAR | .0034121 | .0023592 | 1.45 | 0.148 | -.0012118 .008036 |
| PERCEP | .3820961 | .2633493 | 1.45 | 0.147 | -.1340591 .8982513 |
| ACCPS | .4279142 | .2875316 | 1.49 | 0.137 | -.1356374 .9914658 |
| SOCORG | -.4319855 | .268645 | -1.61 | 0.108 | -.95852 .094549 |
| Cons | -.0600367 | 1.047969 | -0.06 | 0.954 | -2.114018 1.993944 |
| /atrho21 | .4604255 | .2914451 | 1.58 | 0.114 | -.1107965 1.031648 |
| /atrho31 | -.5359687 | .2685849 | -2.00 | 0.046 | -1.062385 -.009552 |
| /atrho41 | -.9829641 | .2778767 | -3.54 | 0.000 | -1.527592 -.4383359 |
| /atrho32 | -.4104796 | .3176169 | -1.29 | 0.196 | -1.032997 .212038 |
| /atrho42 | -.4707276 | .2321273 | -2.03 | 0.043 | -.9256888 -.0157664 |
| /atrho43 | .0936811 | .1948877 | 0.48 | 0.631 | -.2882918 .4756539 |
| rho21 | .430431 | .2374489 | 1.81 | 0.070 | -.1103453 .7745683 |
| rho31 | -.4899304 | .204116 | -2.40 | 0.016 | -.7865751 -.0095517 |
| rho41 | -.7543462 | .1197542 | -6.30 | 0.000 | -.9100117 -.4122641 |
| rho32 | -.3888798 | .2695844 | -1.44 | 0.149 | -.7751076 .2089164 |
| rho42 | -.438787 | .1874349 | -2.34 | 0.019 | -.7285775 -.0157651 |
| rho43 | .093408 | .1931873 | 0.48 | 0.629 | -.2805619 .4427563 |

Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0:
chi2(6) = 30.4755 Prob > chi2 = 0.0000

 

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