Impacts of mobile phone coverage expansion on market participation: panel data evidence from Uganda

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Abstract

Uganda has experienced recently a rapid increase of area covered by mobile phone. As the information flow increases due to the mobile phone coverage expansion, the cost in crop marketing is expected to decrease, particularly more so for perishable crops, such as banana, in remote areas. We use panel data of 856 households in 94 communities, where the number of the communities covered by the mobile phone network increased from 41 to 87 communities over a two-year period between the first and second surveys in 2003 and 2005, respectively. We find that the proportion of the banana farmers who sold banana increased from 50 to 69 percent in the communities more than 20 miles away from district centers after the expansion of the mobile phone coverage. For maize, which is another staple but less perishable crop, we find that mobile phone coverage did not affect market participation. These results suggest that mobile phone coverage expansion induces market participation of farmers who are located in remote areas and produce perishable crop.

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1. Introduction

An important route to reduce poverty in rural areas is considered to enhance market participation of rural farmers, as it can increase net returns to agricultural production (World Bank, 2007--WDR2008). However, many farmers in Sub-Saharan Africa remain subsistence farmers whose production activities are conducted mainly for home consumption (Verheye, 2000). In the case of Uganda, one-third of farmers surveyed in 1992/93 were subsistence or autarky farmers, and even the rest of them marketed less than 10 percent of their output (Larson and Deininger 2001). One strong reason for remaining subsistence is high cost to participate in marketing. A better access to information is expected to reduce such cost and encourage market participation. For instance, a study of fishermen in India finds that the mobile phones help fishermen to choose a fish market where they can sell their fish for a higher price (Jensen, 2007).

In recent years, mobile phone networks have been expanding in many African countries, including Uganda. In 2004, the average number of mobile cellular units per 100 inhabitants in Africa reached 9.1, with the annual growth rate during 1999 to 2004 being 59.7% (ITU 2006). Although an increased access to information via mobile phones can potentially increase farmers' market participation in areas with road accessibility, there are no studies on the impacts of mobile phone network expansion on market participation of farmers.

The purpose of this study, therefore, is to assess the impact of mobile phone network expansion on farmers' market participation in Uganda. In Uganda, the mobile phone network expanded from 46.0% of the population in 2003 to 70.0% in 2005 (ITU 2007). In this study, we use panel data of 856 households in 94 communities across the country, except north regions. During a two-year period between the first survey in 2003 and the second survey in 2005, we find that the mobile phone network expanded from 41 to 87 communities out of the 94 sample communities. The mobile phone network was not yet available in the remaining nine communities even in 2005.

We expect that the impacts of increased flow of information are larger on perishable agriculture products than cereals because prices of perishable products are highly dependent on freshness at the time of exchange. The mobile phone network can help both producers and traders to transport and market perishable products quickly to avoid spoilages. In Uganda, banana (matooke) is an important staple crop and is highly perishable. Thus, we expect to find a larger impact of information flow on crop marketing of banana than maize, which is another important staple crop but much less perishable than banana.

In the next section, we review previous studies linking market access to poverty, as well as impact assessments for telecommunications. Section 3 presents the conceptual framework. Section 4 presents the data, descriptive statistics, and the estimation method. Estimation results are reported in Section 5, followed by conclusion and discussion in Section 6.

2. Literature Review

Previous empirical studies on the geographical concentration of poverty point the positive relationship between distance to markets and the poverty incidence. Stifel et al. (2003) find that the incidence of poverty in rural Madagascar increases with remoteness. Minot (2005) indicates that in Tanzania, poverty is positively associated with distance to regional urban centers. However, the causal relationship between access to markets and poverty is not clearly identified in these studies that use cross-section data.

Aside from numerous anecdotal articles regarding the impact of mobile phone on poverty reduction, Jensen (2007) rigorously assesses the impact of the introduction of mobile phone on the fishing markets in India. The paper shows that the fishermen increase arbitrage among local fish markets after the introduction of mobile phone, leading to a decrease in the variation in fish price and reduction of spoilage. The existing studies with similar attention to telecommunication (mostly landline) include Tolero et al. (2006) on the impact of telecommunications on poverty reduction measuring willingness to pay for telecommunication service in Peru and Bangladesh, Chong et al. (2006) on the impact of access to public telephone using quasi-natural experiment data from Peru, and Bayes' (2001) analysis on village pay phones in Bangladesh reporting that agricultural output prices were higher in villages with those phones. Focusing on trading, Overa (2006) reports that higher occurrence of telephone use by traders, especially among traders of perishable food items, reduces spoilage. So far, there are no studies on the impacts of the expansion on mobile phone network coverage on market response of farmers.

In Uganda, some 2.5 million smallholder households produce 94% of total agricultural production and constitute 80% of the employed population. Using cross section household/community data collected in 1992/93 Uganda, Larson and Deininger (2001) show that the (landline) telephone variables had significant impacts on the difference between district and local prices. Fan et al. (2004) find that the Ugandan government's spending on rural roads had a substantial impact on rural poverty reduction. However, Pender et al. (2004) find little evidence between access to markets and output value in rural Uganda. Thus, previous studies on Uganda have not shed clear light on the impacts of mobile phone network expansion on market participation of farmers.

In addition, most previous analyses are in reduced form, linking the telephone network expansion with welfare indicators such as income or expenditure, but do not explicitly consider the pathways in which better access to information increases income through price or through increase in production. Therefore, the purpose of this study is to estimate the impact of the mobile phone network expansion on market participation in Uganda, by using panel data. We compare the changes in price and market participation over the two surveys in 2003 and 2005 between areas that were covered by the mobile phone network in both years and areas that were covered not in 2003 but in 2005.

3. Conceptual framework

Consider the farm gate price ${p^{FG}}_i = p_i^M - \gamma(I) \times \tau$ for agricultural products (Figure 2). p_i^M is the market price of commodity i. τ is a measure of transportation related cost, which is proportional to distance between the market and farmer. $\gamma\,(I)$ is the sensitivity of output price with regard to the distance to market. With one unit increase in distance, the farm gate price decreases by $\gamma\,(I)$. With one unit increase in information, γ decreases, therefore $\frac{\partial(\gamma)}{\partial(I)} < 0$. Mobile phone coverage increases the flow of information and thus the efficiency in marketing, leading to lower level of γ. The incremental change in γ due to increase in flow of information (I) is expected to be larger for perishable crop such as banana, and less for maize which is a less perishable product.

$\left|\frac{\partial(\gamma_b)}{\partial(I)}\right| > \left|\frac{\partial(\gamma_m)}{\partial(I)}\right|$ γ_b is for banana while γ_m is for maize.

The potential gain for farmers Δp^{FG} can be derived as follows:

$$\Delta p^{FG} = p_1^{FG} - p_0^{FG}$$

$$= p^M - \gamma'(I_1)\tau^* - p^M + \gamma(I_0)\tau^*$$

$$= -\{(\gamma'(I_1) - \gamma(I_0)\}\tau^*$$

as $I_1 > I_0$, $\{(\gamma'(I_1) - \gamma(I_0)\} < 0$ therefore, $\Delta p^{FG} > 0$

In practice, traders use mobile phones to set up time and place to trade banana (FASID, 2007). When mobile phone network is not available, traders usually visit banana producing areas without prior announcement and spend several days to fill up their trucks with banana. However, when the area is covered by mobile network, the traders can contact the communities in advance and fill up their trucks within the day. Fresher bananas collected this way can fetch higher prices in the market. At the same time, traders can increase the frequency of collecting activities.

During 2003 to 2005, Uganda experienced an expansion of mobile phone coverage from 46.0% to 70.0% of the population where traders intensified their trading activities. At the same time, the majority of the farmers in Uganda remained without mobile phones. Indeed, traders with more information are the driving force underlying the marketing efficiency improved with mobile phone coverage.

The potential gain Δp^{FG} is expected to be captured by farmers if there is no information asymmetry between farmers and traders. The competition among traders to whom the farmers sell their products will increase the actual farm gate price, which would exceed the reservation price for farmers. In contrast, if the trader has a monopoly over market information, the trader keeps the actual farm gate price just a little above the reservation price of the farmers, so that the farmers sell their products but with little gain. This is more likely to be the case in areas remote from the district centers, where price information is less diffused. If the farmers are well informed of the market prices, the actual farm gate price will be the level of market price minus only the transportation cost and the remaining gain will be captured by the farmers..

Therefore, when information asymmetry between traders and farmers remains in favor of the traders, actual farm gate prices are not expected to increase significantly although market participation of farmers is expected to increase. This is different from the case of fishermen in India discussed in Jensen's paper, where producing and marketing activities are conducted by the same entity, the fishermen to whom the potential and actual prices are the same . In our case, as the farmers become more informed overtime, the traders are expected to bring the actual farm gate price closer to the potential level.

Since the mobile phone provides price and other market information regardless of distance from the market centers, it seems reasonable to postulate the hypothesis away that by increasing information as a result of mobile phone network coverage expansion, the farther the farm household is located from the district center, the larger its impacts on farmers' behavior including market participation. The above effect is stronger in the case of perishable crop such as banana of which freshness at time of exchange determines the sales value to a significant extent. However, this does not mean that the actual farm gate price approaches fully to its potential level due to the information asymmetry between the farmers and the traders, particularly in areas far from district centers as is indicated in Figure 2.

4. Data, descriptive analysis and estimation method

4.1 Data and descriptive analysis

This paper uses data from household and community surveys in Uganda collected as part of the Research on Poverty, Environment, and Agricultural Technology (REPEAT) project. The surveys were jointly conducted by Makerere University, the Foundation for Advanced Studies on International Development (FASID), and National Graduate Institute for Policy Studies (GRIPS) in 2003 and 2005. The surveys covered 29 districts in West, Central, and East regions of Uganda, representing major farming systems of the country. The dataset is unique in including data on spatial location and infrastructure such as distance to district centers/market, information on mobile phone network expansion as well as mobile phone possession by the household. In 2003, the baseline survey collected information from 94 Local Counsel 1s[1] and ten households from each LC1, making a total of 940 households. In 2005, we conducted a follow-up survey of the 940 households and interviewed 856 households successfully. In the both surveys, we conducted both household and community surveys. In the community survey, we have asked about road accessibility

[1] LC1 is the smallest administrative unit in Uganda.

and telecommunication, such the availability of the mobile phone network.

We stratify our samples by the mobile network coverage in Table 1. We find that about 42 percent of the sample households were covered already by the mobile phone network by the time of the 2003 survey. By the time of the second survey in 2005, 92 percent of the total households have been covered by the mobile phone network. As for the household mobile phone ownership, only 4.3 percent of the households possessed at least one unit in 2003, while in 2005 the percentage increased to 11.5 percent.

We further stratify our sample of banana farmers in Table 2 into two groups according to the timing of the mobile phone coverage and present the ratio of households who have sold crops and the ratio of sales out of production. The first group is the households who were covered by the network at the time of the 2003 survey, and the second group is the households who have been covered by the network in between the 2003 and 2005 surveys. We exclude households who have never been covered by the network to simplify our analysis. Then, we further stratify our samples by the distance to the district center, where markets are usually located because we think that the impacts of the mobile phone network on crop sales would depend on the distance to markets.

In the case of banana, we find a large increase in the ratio of household selling banana in locations more than 20 miles from the district centers. The proportion of the households who sold banana increased from 50 percent in 2003 to 68.8 percent in 2005 in locations where the mobile phone network became available after the 2003 survey. We also find that the proportion of banana sales out of production increased by 11.7 percentage points among the same group. In contrast, the proportion of the household who sold banana increased only by 3.8 percent in locations where the mobile phone network was available in 2003. Thus, we conjecture that the mobile phone network had a positive impact on banana sales in these locations.

Table 3 is the case of maize. For areas newly covered by mobile phone network sometime between 2003 and 2005, we find an increase in the ratio of sellers among producers from 47.5% to 52.3% in locations closer than 20 miles from the district center. The proportion of maize sales out of production did not show significant difference regardless of mobile phone coverage expansion.

4.2 Estimation Method

In the following sections, we estimate the determinants of 1) possession of mobile phone at the household level, 2) banana and maize market participation, 3) proportions of production sold out of production of banana and maize, and 4) 2005/2003 relative prices of banana and maize. As explanatory variables, we include the 2005 survey year dummy, *yr05*, the dummy for community level mobile phone network coverage, *LC1mob*, and distance to district center, *miles*. The interaction term between the community level mobile phone coverage, *LC1mob*, and the distance to district center, *miles*, is also included to examine the combined effect of mobile coverage and distance to market.

1) Possession of mobile phones at the household level

$$\Pr(HHmob = 1)_{it} = \beta_0 + \beta_1 yr05_t + \beta_2 LC1mob_{jt} + \beta_k X_{it} + \beta_l Z_{jt} + \alpha_i + \varepsilon_{it}$$

where t =2003 and 2005, X_{it} is household characteristics, Z_{jt} is community characteristics, and α_i is time-invariant unobserved household and community characteristics. First, we estimate this model with Probit model because the dependent variable is a dummy variable, which takes one if the household possesses at least one mobile phone unit. Then, to estimate a more precise estimator of the impact of the mobile phone coverage at the community level, we estimate the same model with the fixed effects (FE) model at the household level. By estimating the FE model, we eliminate any biases caused by the time-invariant unobserved household and community characteristics.

In the following models, we estimate the impacts of the mobile phone coverage at the community level and mobile phone possession at the household level on crop marketing. Because the mobile phone possession at the household level is endogenous, we treat it as an endogenous variable by applying the fixed effects instrumental variables (FE-IV) model. We use interaction terms between the dummy variable for the mobile phone coverage at the community level and the initial household characteristics as instrumental variables. Because we apply the household level FE models, the initial household characteristics cannot be included in the FE models. Then, we interact them with the dummy variable for the mobile phone coverage at the community level, which is time-variant, so that we can identify the mobile phone possession at household level with the interaction terms.

For instance, the initial level of household assets is expected to have a larger positive impact on the household mobile phone possession when the community is covered by the mobile phone network. Thus, the interaction term between the initial household assets variable and the community level network coverage is also expected to have a large positive impact on the mobile phone possession and can be used as an instrumental variable. Thus, as instrumental variables, we use the interaction terms between the community level mobile phone network and the following initial household characteristics: the farm asset value in log, the age of household head, the education level of male adults, and the education level of female adults.

2) Decision whether to sell to the market

For household's decision whether to sell to the market, we estimate the impact of the mobile phone possession at the household level, and the mobile phone network coverage on the participation in the banana and maize markets by estimating the following model with the household FE-IV model:

$$\Pr(S_i > 0)_{it} = \beta_0 + \beta_1 HHmob_{it} + \beta_2 LC1mob_{jt} + \beta_3 LC1mob_{jt} * miles + \beta_4 yr05_t + \beta_k X_{it} + \beta_l Z_{jx} + \alpha_i + \varepsilon_{it}$$

Our hypotheses suggest that the estimated coefficients of the mobile phone variables would be larger on banana marketing than maize marketing because banana is more perishable than maize and there are larger margins to be reduced in the banana than maize. Further, we hypothesize that the impact is larger in areas farther away from the district center and, hence, the estimated coefficient of the interaction term between the mobile phone coverage at the community level and the distance from the district center is expected to be positive. Because producers decide whether they sell their products or not by comparing their reservation price and the actual farm gate price, ideally household characteristics should be considered in the estimation equation. However, because we estimate the household level fixed effects model, the fixed household characteristics are excluded from the equation.

Following the same estimation strategy, we estimate the following model for the decision on the rate to sell:

3) Decision on the rate to sell

$$S_{it} / Q_{it} = \beta_0 + \beta_1 HHmob_{it} + \beta_2 LC1mob_{jt} + \beta_3 LC1mob_{jt} * miles$$
$$+ \beta_4 yr05_t + \beta_k X_{it} + \beta_l Z_{jt} + \alpha_j + \varepsilon_{it}$$

4) 2005/2003 price ratio

The actual farm gate price is expected to be lower than the market price in district towns due to the transport cost and information asymmetry between the farmers and the traders, particularly in areas far from district centers. To confirm this, we estimate the following model:

$$p_{i05}^{FG} / p_{i03}^{FG} = \beta_0 + \beta_1 LC1mob_j + \beta_2 LC1mob_j * miles + \beta_3 miles + \varepsilon_{it}$$

The coefficient of the interaction term between mobile phone coverage and the distance to district center is expected to be negative. This is because the information asymmetry between farmers and traders allows the traders to retain the majority of the efficiency gain created by the increase of information flow, while the farmers increase supply because the new farm gate price at least exceeds the reservation price. This effect is expected to be greater in distant areas.

Below are some of the characteristics of the variables:

*LC1mo*b and *HHmob*: Mobile telephone network rapidly expanded between the survey years. In 2003, around 42% of the communities responded that they had mobile phone coverage, while in 2005 about 92% of the communities did. The earliest coverage by mobile network was in 1995. In 2005, 11.5% of the households possess handsets, while in 2003 the same rate was 4.3% .

miles: Uganda's road transport system comprises a classified network of about 9,000 km of main roads, and 20,000 km of feeder roads (generally gravel). In addition, there are 60,000 km of community/ access roads and tracks in the sub counties. Feeder roads are the main links from the main roads to the towns/villages where marketing centers are located. Community roads connect farms to marketing centers. Community roads are usually passable on foot or with bicycles, and, sometimes by motorcycles or four-wheel drive vehicles. As much as 88% of the communities surveyed in 2005 responded that they are connected to the nearest district town by all season tarmac or dirt road. In 2003, the corresponding number was 84%. When asked if it is possible to drive there, 97% of the communities responded that it was possible to drive both in

2005 and 2003. This suggests that the road condition in the surveyed communities did not change much between 2003 and 2005.

5. Results

We first present the estimation results on the determinants of household mobile phone possession in Table 4. The Probit result suggests that the dummy variable on the mobile phone network coverage at the community level has a positive and significant impact on the mobile phone possession. Among household characteristics, the total value of farm related assets and the education level of both male and female household members increase the possession significantly. The age of the household head has a negative impact, suggesting that households with young heads are buying mobile phones. The FE results confirm the positive effect of the dummy on mobile network coverage on mobile handset possession.

Next, we present the OLS results on the price ratio (2005/2003) of banana and maize in Table 5. The impact of mobile phone network expansion between 2003 and 2005 by itself is large and significant. The interaction term between the distance to the district center and the mobile phone coverage have negative coefficient for banana with regard to areas newly covered by mobile phone network between 2003 and 2005.

This is in line with the previous discussion that when information asymmetry between farmers and traders remains, the traders retain the majority of the efficiency gain created by the increase of information flow, while the farmers increase supply because the new farm gate price at least exceeds the reservation price. Also, the result supports the hypothesis that such effect is greater in distant places. The same coefficient is negligible for maize.

The result of FE regression on market participation regarding banana in Table 6 shows a significant positive effect of with the interaction term combining distance to district center and mobile phone coverage. As indicated by Figure 2, this result supports the hypothesis that the farther the farmer is located from the district center, the more market participation is induced by mobile phone coverage. The result does not change even after applying instrumental variables (FE-IV), supporting the same hypothesis.

At the same time, application of instrumental variables weakens the significance of the impact of household mobile possession on market participation. This result suggests that mobile network coverage, rather than farm household's mobile possession, induces market participation, because more efficient marketing practice of traders made possible by use of mobile phone reduces information related transaction cost. Indeed, most of the farmers in Uganda sell to traders at the farm gate who market the crop.

We show the same analysis regarding maize in Table 7. Here, neither mobile coverage nor interaction term combining distance and mobile coverage showed significant effect of ratio of household who sell or ratio of sale among produced amount. This may be due to the fact that maize is a less perishable cereal where marketing efficiency through mobile phone does not significantly decrease transaction cost.

Lastly, Table 8 shows the analysis regarding production income per household of banana, where we can confirm a significant positive effect with the interaction term between distance to district center and mobile phone coverage. This result suggests that the supply response by banana farmers who are located far from district centers contributes to poverty reduction. In the third column, we have added three interaction terms combining mobile coverage and land owned, mobile coverage and education of household head, and mobile coverage and female headed household dummy. The purpose of this exercise is to find if any household characteristics affect income. The negative coefficient for the interaction term between mobile coverage and land owned suggest that the income increase was experienced by smaller land holders.

6. Conclusion and discussion

Enhancing farmers' participation in markets is considered as an important strategy to reduce rural poverty in Africa. This paper uses panel data from Uganda to test the hypothesis that mobile phone coverage expansion induces more market participation of farmers in remote areas producing perishable crop such as banana.

Uganda experienced recently a rapid increase in area covered by mobile phone. As information flow increases due to the mobile phone coverage expansion, the cost in crop marketing is expected to decrease, particularly in remote areas measured by the distance from the district centers. Indeed, we find that banana farmers located farther from district centers participated more in the market and increased their income after the coverage by the mobile phone network. For maize which is another staple but less perishable crop, we find that mobile phone coverage did not affect market participation. The above results suggest that mobile phone coverage expansion induces more market participation of farmers who are located in remote areas and produce perishable crop.

However, there is a possibility that the efficiency gain due to mobile phone expansion is mainly achieved by traders who make use of mobile phones and penetrate to into previously unexploited remote areas. When asked about the place to sell their produces in 2005, 81.5% of banana farmers answered that they sell on farm. Banana farmers sold to traders (80.6%) who had contact by chance (82.7%). These numbers suggest that the majority of the banana farmers are passive in marketing their produces and support the conjecture that traders became active in areas covered by mobile phone network and took the majority of the efficiency gain.

In order to make farmers fully realize their potential efficiency gain, information asymmetry between traders and farmers should be overcome. One route to reduce information asymmetry is to strengthen public dissemination of banana market price. Another route is to enhance the capacity of the community to obtain and share timely price information, for example, through banana producers' associations.

Nevertheless, the evidence in this paper suggests that in remote areas in rural Uganda, mobile phone coverage expansion by itself, not necessarily mobile phone possession, benefit the small farmers who produce perishable produces that was not possible to market before.

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Table 1: Mobile Phone Network Coverage and Ownership

Region	Number (%) of households	Number (%) of sample households by mobile phone network coverage			Proportion (%) of households who own mobile phone units	
		2003 and 2005	Only in 2005	Never covered	2003	2005
Eastern	383 (44.7)	133 (34.7)	221 (57.7)	29 (7.5)	2.6	8.6
Central	250 (29.2)	123 (49.2)	127 (50.8)	0 (0)	8.0	17.6
Western	223 (26.0)	107 (47.9)	77 (34.5)	39 (17.4)	3.1	9.8
Total	856 (100)	363 (42.4)	425 (49.6)	68 (7.9)	4.3	11.5

Table 2: Mobile Coverage/ Ratio of Sellers and Sales, Banana

	Mobile coverage	Ratio of sellers among producers (%)			Ratio of sales among production (%)		
		2003	2005	Dif. (t-value)	2003	2005	Dif. (t-value)
All locations	N/Y	48.3	53.4	5.1 (-1.19)	20.1	24.6	4.5** (-2.14)
	Y/Y	54.0	50.7	-3.3 (0.12)	19.6	22.8	3.2** (-2.06)
More than 20 miles	N/Y	50.0	68.8	18.8** (-2.13)	18.4	30.1	11.7*** (-2.66)
	Y/Y	67.3	71.1	3.8 (0.00)	24.5	30.5	6.0 (0.19)
Less than 20 miles	N/Y	47.6	46.1	-1.5 (-0.13)	20.8	22.0	1.2 (-1.01)
	Y/Y	50.9	46.5	-4.4 (0.12)	18.5	21.2	2.7** (-2.26)

N/Y: No mobile phone coverage in 2003; covered in 2005

Y/Y: Covered in both 2003 and 2005

Table 3: Mobile Coverage/ Ratio of Sellers and Sales, Maize

	Mobile coverage	Ratio of sellers among producers (%)			Ratio of sales among production (%)		
		2003	2005	Dif. (t-value)	2003	2005	Dif. (t-value)
All locations	N/Y	48.5	52.0	4.5* (-1.73)	25.2	24.4	-0.8 (-0.47)
	Y/Y	51.8	50.9	-0.9 (0.38)	24.7	24.2	-0.5 (0.91)
More than 20 miles	N/Y	51.1	51.3	0.2 (-0.53)	28.0	24.7	3.3 (-0.64)
	Y/Y	69.7	65.8	-3.9 (0.43)	38.2	37.1	-1.1 (1.17)
Less than 20 miles	N/Y	47.5	52.3	4.8* (-1.67)	24.2	24.3	0.1 (-0.19)
	Y/Y	48.4	48.2	-0.2 (0.26)	22.1	22.0	-0.1 (0.38)

N/Y: No mobile phone coverage in 2003; covered in 2005

Y/Y: Covered in both 2003 and 2005

Table 4: Determinants of Household Mobile Possession

	Household mobile possession with mobile coverage dummy	
	Probit	Fixed Effects
Year 05(=1)	0.024 (3.33)***	0.042 (4.08)***
Mobile coverage dummy	0.025 (3.51)***	0.054 (3.80)***
Household Characteristics		
Size of household	0.010 (1.13)	
No. of male adults	-0.013 (-1.38)	
No. of female adults	-0.013 (-1.36)	
No. of boys	-0.003 (-1.07)	
No. of girls	0.001 (0.55)	
Age of household head	-0.001 (-4.06)***	
Gender of head (fem=1)	-0.001 (-1.05)	
Widowed household (yes=1)	0.022 (1.12)	
Education of male adult	0.004 (4.21)***	
Education of female adult	0.005 (5.65)***	
ln (land)	-0.001 (-0.51)	
ln (farm assets)	0.014 (6.50)***	
# of observations	1755	1755

Table5: 2005/2003 Price Ratio at Household Level: Banana and Maize
(Sellers in both 2003 and 2005)

Variables	Price ratio of Banana (05/03)	Price ratio of Maize (05/03)
Mobile Coverage dummy (N/Y)	2.015**	-0.258
	(2.42)	(-1.15)
Distance to district center (miles) x Mobile Coverage (N/Y)	-0.918**	0.011
	(-2.36)	(1.08)
Distance to district center (miles)	0.083**	-0.010
	(2.53)	(-1.30)
Constant	0.074	1.185***
	(0.12)	(8.13)
#of observations	107	98

Table 6: Market Participation and Mobile Coverage/Possession: Banana

Variables	Pr(Selling Banana)			Ratio of sales quantity out of production		
	FE	FE	FE-IV	FE	FE	FE-IV
Household Mobile Phone Possession dummy [(A)]	0.203** (2.35)	0.209** (2.44)	0.151 (0.19)	0.118** (2.39)	0.121** (2.45)	-0.062 (-0.14)
Community Mobile Phone Coverage dummy	0.055 (1.57)	-0.095 (-1.41)	-0.094 (-1.11)	0.054*** (2.68)	-0.011 (-0.29)	0.000 (0.02)
Distance to district center (miles) x Mobile Coverage		0.008*** (2.62)	0.007*** (2.53)		0.003** (1.99)	0.003** (1.81)
Year 05(=1)	0.481*** (17.73)	0.502*** (17.84)	0.505*** (10.85)	0.174*** (11.18)	0.183*** (11.31)	0.191*** (7.04)
F-stat on IVs			2.58			2.58
#of observations	1161	1161	1151	1161	1161	1151

Note 1: (A) Instrumental variables: In the case of mobile coverage dummy, Household mobile possession (HHmobile) is instrumented by (mobile coverage dummy *lnfarmassets), (mobile coverage dummy) *(age of household head), (mobile coverage dummy)*(education of male adult), (mobile coverage dummy)*(education of female adult). These IVs together passed overidentification test at 1% significance level.
Note 2: Variable on the distance to district center is dropped when applying FE model.

Table 7: Market Participation and Mobile Coverage/Possession: Maize

Variables	Pr(Selling Maize)			Ratio of sales quantity out of production		
	FE	FE	FE-IV	FE	FE	FE-IV
Household Mobile Phone Possession dummy (A)	-0.084 (-1.10)	-0.083 (-1.09)	-2.19 (-2.04)	-0.031 (-0.71)	-0.031 (-0.71)	-0.172 (-0.42)
Community Mobile Phone Coverage dummy	0.075** (2.39)	0.033 (0.58)	0.165 (1.47)	0.010 (0.55)	0.004 (0.13)	0.012 (0.29)
Distance to district center (miles) x Mobile Coverage		0.002 (0.86)	0.000 (0.18)		0.000 (0.20)	0.000 (0.06)
Year 05(=1)	0.463*** (19.06)	0.468*** (18.79)	0.561*** (9.31)	0.242*** (17.10)	0.243*** (16.73)	0.251*** (10.99)
F-stat on IVs			2.58			2.58
#of observations	1291	1291	1283	1291	1291	1283

Note 1: (A) Instrumental variables: In the case of mobile coverage dummy, Household mobile possession (HHmobile) is instrumented by (mobile coverage dummy *lnfarmassets), (mobile coverage dummy) *(age of household head), (mobile coverage dummy)*(education of male adult), (mobile coverage dummy)*(education of female adult). These IVs together passed overidentification test at 1% significance level.
Note 2: Variable on the distance to district center is dropped when applying FE model.

Table 8: Production Income and Mobile Coverage/Possession: Banana

Variables	Production income (Shs)			
	FE	FE	FE	FE-IV
Household Mobile Phone Possession dummy [(A)]	-86,385 (-1.04)	-93,333 (-1.11)	-82,829 (-0.97)	234,283 (0.49)
Community Mobile Phone Coverage dummy	-134,851** (-2.09)	-2,775 (-0.08)	-42,664 (-0.57)	-159,937** (-2.16)
Distance to district center (miles) x Mobile Coverage	7,397** (2.45)		7,543** (2.48)	7,861** (2.49)
Land Owned x Mobile Coverage			-84,316*** (-2.65)	
Household Head Education x Mobile Coverage			Dropped	
Female Household Head Dummy x Mobile Coverage			2,247 (0.03)	
Year 05(=1)	199,122*** (7.07)	182,141*** (6.65)	198,461*** (6.34)	187,251*** (5.25)
F-stat on IVs				9.52
#of observations	1503	1503	1482	1482

Note 1: (A) Instrumental variables: In the case of mobile coverage dummy, Household mobile possession (HHmobile) is instrumented by (mobile coverage dummy *lnfarmassets), (mobile coverage dummy) *(age of household head), (mobile coverage dummy)*(education of male adult), (mobile coverage dummy)*(education of female adult). These IVs together passed overidentification test at 1% significance level.

Note 2: Variable on the distance to district center is dropped when applying FE model.

Figure 1 Mobile phone network coverage expansion in Uganda

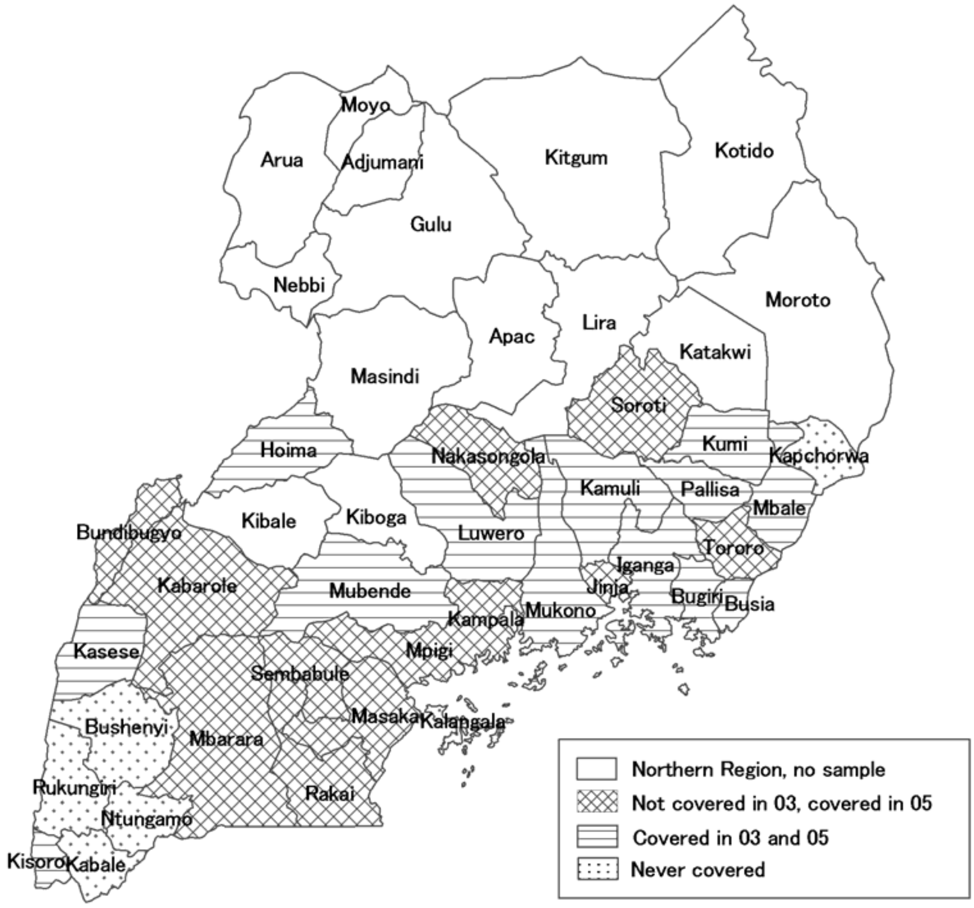

Figure 2: Conceptual Banana Price Schedule and Impact of Mobile Phone Coverage Expansion