

Full Length Research Paper

Impact of ICT use on access to markets of pineapple smallholder farmers in Benin

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Abstract

This paper has used propensity score matching estimation to test the hypothesis that the access of smallholder pineapple farmers to information reduces the costs of doing business, increases income and hence increases market linkage in Benin. Evidence showed that, during transactions, the use of cell phone saves time and allows the producer to save money which was used for multiple trips. The mobile phone facilitates transactions and provides access on time, to relevant information. Thus, its use allows pineapple producers to sell their produce at a good price and significantly improve their income. The use of information and communication technology thus appears important and recommended in the production of cash crops, for which the need for information is of paramount importance. Therefore, we suggest that it is implemented, the conditions for the adoption and general use of ICT in rural areas.

Keywords: Mobile phone, smallholder farmers, pineapple, market, income.

INTRODUCTION

In recent years, the issue of agricultural market access in developing countries has been greatly considered. There has been a shift from building up farmers' production capabilities to facilitating farmers' access to markets, as the opportunity for smallholders to raise their incomes from agricultural production, natural resource management and related rural enterprises depends on their ability to participate successfully in markets (Shepherd, 2007). Lack of market access is the major obstacle facing small-scale farmers and, if solved, will improve incomes, food security, rural employment, and sustained agricultural growth (Dorward et al., 2003; Poulton et al., 1998; Stiglitz, 2002). In response, attention is on making key business development services such as market information, input supplies and transport services available (Miehlbradt and McVay, 2005). The general aim of this study is to evaluate whether market information provided by the use of Information and Communication Technologies (ICTs) leads to increased market access.

The use of ICT-based market information services in developing countries allows small-scale farmers to get linked to the other actors of the supply chain and thus improve the farmers' access to markets (CTA, 2008). Much of the literature on market access highlights the

pervasive imperfections of markets in the developing world (De Janvry et al., 1991). Lack of information on prices and technologies, lack of linkages between farmers, processors, traders and retailers, distortions or absence of input and output markets, and credit constraints often make it difficult for small farmers to take advantage of market opportunities. Traditionally, small farmers sold their crops at the farm gate to intermediaries, often at a low price (Fafchamps and Vargas-Hill, 2005). The presence of intermediaries characterizes the trade structures in developing countries and expresses high transaction costs in the agricultural exchanges.

Recent development interventions have been promoting information transfer through ICT-based innovations to reduce the asymmetric information among the market players and create linkages between the actors in the chain that eventually benefit small scale farmers (Tollens, 2006; Aker, 2008). The ICTs used included radio, television, landline phone, mobile phone, computer, internet, etc. Studies have showed that the use of mobile phones reduces information costs, price dispersion across markets, and price fluctuations within the same markets and improves market knowledge,

transaction process characteristics, and trade (Abraham, 2007; Aker, 2008; Jagun et al., 2007). The introduction of internet kiosks (Goyal, 2010) and mobile phones (Jensen, 2007) is also associated with higher price of the products farmers sell and lower transaction costs which contribute to higher incomes (Annamalai and Rao, 2003).

ICT-based market interventions have also existed in Benin but have been mainly biased toward traders' organizations. Its extension to smallholder farmers has been experimented in the field of staple crops stimulated just in one of the eight Benin agro-ecological zones. A study has been undertaken and aimed to assess the impact of ICT use by these farmers on their access to markets. Even cash crops are not taken into account by any ICT-based market initiative, although producers especially those who invest in pineapple cropping use mobile phone to get agricultural information. Yet nothing is done to assess the effect of mobile phone use on access to market of pineapple producers. The present study is carried out in order to fill this gap.

This study will focus on the production and marketing aspects only and will not go into value addition process such as processing. The paper is organized as follows. Section two brings transaction cost theory in market linkage and poses the study hypothesis. Section three exposes the empirical methodology and describes the data. Section four provides the findings and discusses them. Section five finally concludes with some further research areas.

LITERATURE REVIEW

Advent of mobile phone

The mobile phone is a component of Information and Communication Technology (ICT). The latter are defined as a set of tools used to produce, process and exchange information in near real time. The promotion of these technologies for sustainable human development started in Benin, with the Sector Policy Statement of November 1994. It was followed by creating ongoing since August 2006 of the institutional and regulatory environment necessary for the emergence of a new economic and social dynamic and enterprising sector, and adopting the same year of Benin ICT Plan. In the same vein, capacity building of human resources essential to the achievement of objectives and development of basic infrastructure for the democratization of access to information is all acts to achieve this promotion.

In Benin, the mobile phone is in many localities, the only means of access to telecommunications. The cell phone sector has been liberalized since 1997 and includes in addition to the state owned company, four (4) functional operators: Moov (formerly Telecel), MTN (formerly BENINCELL), Bell Benin Communications (former Areeba) and Globacom (Glocom) the latest

company. Geographical coverage by GSM operators is still very low in rural areas. There are over 3.21 million subscribers and 30,000 GSM public cabs and airtime buying centre available.

Services offered by mobile phone

The mobile phone offers consumers through existing GSM networks, voice messaging services and voice written and service roaming. The latter allows staying in touch and communicating around the world from the same local number. Many other services are currently offered to consumers in Benin, however the first two offers are the most commonly used in rural areas.

Voice calls are a technical communication "full duplex" in which information is transmitted on a reciprocal basis, between persons or groups of people using the word. Voice communication is advantageous because it allows transactions to reduced costs, to transmit information without distortion and time, and while for authenticating the source of the information received.

The courier or Short Message Service (SMS) is also used to communicate in languages that are configured in the alphabets laptops. The most commonly used in Benin are French and English. The benefits provided by SMS are a lot. In general, it reduces the time spent on the phone and spending, increases the immediacy and allows communication without disturbing the receiver. There's also the fact that when voice communication is difficult, that of the SMS can substitute him. In business, the text messaging increases customer satisfaction and customer loyalty, allows the flow of information within a network. An equally important advantage of this service is simultaneously sending the same message to multiple recipients (Netmarketing ABC, 2002).

In Benin, a recent study revealed that in a sample of 120 randomly selected pineapple growers, 90% use mobile phones for various purposes. Voice calls and SMS are the essential services they operate to communicate with various types of actors within their relational networks. This is, among other things, the husband / wife (36% of respondents), other family members (100%), friends (99%), pineapple traders (98%) or inputs traders (21%). 29% of calls made cater for, retailers of products / inputs. What is the effect of such use on the linking of small producers to market? That is the question that this study will attempt to answer.

Conceptual framework

Earlier, for Coase (1937), the neoclassical result of efficient markets only obtains when it is costless to transact. The exchange between two trading partners, in our case farmers and buyers, does not operate in a frictionless environment and thus incurs some costs of

doing business so-called transaction costs. Transaction cost theory is part of the New Institutional Economics (NIE) which seeks to explain the significance of market and non-market institutions in economic exchange (Williamson, 2000; Menard, 2005). This theory recognizes that markets are driven by transaction costs created by information asymmetry, bounded rationality, opportunism and asset specificity (Williamson, 1989). Transaction cost theory has been widely used in studying agricultural markets in developing countries (Jaffee, 1995; Jaffee, 2004; Fafchamps, 2004; Fafchamps and Hill, 2005; Okello and Swinton, 2007). In the analysis of agricultural marketing in West-Africa, this theory can be helpful when estimating the impact of new technologies on the institutional structure of markets.

Transaction costs include the costs of information, negotiation, monitoring, coordination and enforcement of contracts (Bardhan, 1989). The higher transaction costs facing smallholder farmers stem from the higher costs of searching for and screening of exchange partners, negotiating the sale of output or purchase of inputs, monitoring and enforcing the terms of exchange and also adjusting to changes in market environment. Farmer access to market information has the advantage in that it reduces the cost of doing business. It therefore allows the farmers to increase net income by reducing the costs. The increased income is in turn expected to provide greater incentives to smallholder farmers to participate in the market. The rationale of this paper is to challenge the integration of production and marketing aspects of the value chain through the following hypothesis: smallholder farmer access to information increases market linkage.

METHODS AND DATA

Analytical framework

To test this hypothesis, propensity score matching technique has been applied for the evaluation of the impact of mobile phone use in agricultural exchanges at the selling side. At the selling side, the impact variables referred to as 'outcomes,' are the transaction costs, the output price and the income. Following Becher and Ichino (2002), the implementation of the techniques consists of estimating the propensity score, choosing the matching algorithm and measuring the impact. The propensity score begins with the estimation of the probit (or logit) model of mobile phone use and ends with the test of the balancing property. As reviewed in Heeks and Molla (2009), the potential determinants of ICT use may be found in four categories, namely the ICT's characteristics (digital features), the personal characteristics (demographics, cognitive skills and asset holdings), the social characteristics (social capital endowment) and the environment characteristics (site/infrastructure). If X denotes the multidimensional vector of these

characteristics and $D=\{0,1\}$ is the indicator of mobile phone use referred to as 'treatment,' the propensity score $p(X)$ is the probability of receiving the treatment given X :

$$p(X) = Pr\{D=1|X\} = E\{D|X\} \quad (1)$$

Suppose Y_{1i} and Y_{0i} denote the realization of random variables Y_1 and Y_0 (which capture the outcome for an individual i , if he does and does not receive the treatment respectively), then the impact of using ICT is:

$$D_i = Y_{1i} - Y_{0i} \quad (2)$$

For those who receive the treatment, we observe only the use of ICT outcome (Y_{1i}) and for those who do not use, a non-use ICT outcome only (Y_{0i}), leading to a fundamental problem in determining causality (Holland 1986). That is, if D_i is a dummy variable indicating the incidence of use of ICT, for each individual the only observed outcome is:

$$Y_i = D_i Y_{1i} + (1-D_i) Y_{0i} \quad (3)$$

The parameter of interest is the Average Treatment Effect on the Treated (ATT). This is the outcome gain from treatment for those who actually are selected into the treatment (Becher and Ichino, 2002; Heckman, 2001). Mathematically,

$$ATT = E\{E\{Y_{1i}|D_i=1, p(X_i)\} - E\{E\{Y_{0i}|D_i=0, p(X_i)\}|D_i=1\} \quad (4)$$

Before calculating the ATT, the balancing property is tested on $p(X)$ and the matching methods are used. The test of the balancing property ensures that the distribution of the relevant characteristics is balanced in the groups of users and non-users of mobile phone in agricultural transactions. This leads to impose the 'common support,' by considering only the individuals whose propensity score belongs to the intersection of the supports of the propensity score of treated (users) and controls (non-users) in the impact estimation. This paper uses different matching methods (radius, kernel and nearest neighbor). With Radius Matching each treated unit is matched only with the control units whose propensity score falls in a predefined neighborhood of the propensity score of the treated unit. With the Kernel Matching all treated are matched with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of treated and controls. The Nearest Neighbor consists of taking each treated unit and searching for the control unit with the closest propensity score. Once each treated unit is matched with a control unit, the difference between the outcome of the treated units and the outcome of the matched control units is computed. The ATT of interest is then obtained by averaging these differences (Becher and Ichino, 2002). When estimating the impact on the net income from trading activities, these three matching methods have been combined with the differences-in-differences approach to control both time-varying selection bias and time-invariant selection bias (Smith and Todd, 2005).

Table 1. Number of calls received and transmitted according to different sources / destinations

Sources/destination	Total	Mode	Percentile		
			25	50	75
<i>Calls received</i>					
Relatives	107	10	12	25	50
Friends	107	30	20	40	60
Traders	103	10	8	15	30
Inputs suppliers	17	10	2	10	25
Workers	54	10	5	10	11,25
<i>Calls made</i>					
Relatives	107	50	15	30	50
Friends	107	50	20	40	60
Traders	102	10	10	16	40
Inputs suppliers	23	5	5	5	20
Workers	82	10	10	15	26,25

Area of study at a glance

The data used in this study were collected in 41 villages in the municipalities of Zè (33) and Allada (8) located about 50 km from Cotonou on the road of Cotonou-Bohicon. The choice of these two municipalities is because they have the greatest assets for pineapple production: land with favorable rainfall from 1000 to 1200 mm, availability of extension services, farmers educated for most, near major load centers and the airport, etc.. Moreover, the two municipalities provide the strongest contributions to the total supply of pineapple in Atlántic Department.

Sampling

Producers surveyed were selected from the apex of districts at random by the interviewers who beforehand were unaware of the environment. These investigators had previously received the list of the 25 districts that comprise the two municipalities. At each apex so selected, the list of producers of pineapple was given to them and the selection was made taking into account the total area of land available for the producer. Small pineapple producers in the area are characterized by land size up to two hectares, and form about 77% of the total number of producers. Each investigator was asked to consider this proportion to the level of all lists. Thus, 92 small producers were surveyed against 28 for large producers, a sample size of 120. Interviewers are two in number, one sociologist and one licensed in agronomy. They were the best by their performances in previous surveys and have actively participated in the data input thereto. The base is designed in SPSS version 16. Processing and data analysis were performed in SPSS 16 and STATA 10.1 softwares.

RESULTS AND DISCUSSION

Descriptive analysis

The mobile phone is the information and communication tool the most used by pineapple growers in southern Benin. Table 1 shows the average number of calls made and received in a month according to the sources / destinations. It emerges that among the calls, friends of the producer have the spotlight. The rank of this category of actors can also include professional friends, so that information sharing between agricultural stakeholders in the same profession still appears necessary. Then come the family members followed by traders of products and inputs, and finally looking for workers. These results show that the mobile phone is actually used in the production of pineapples. Indeed, the pineapple grower has a good perception of the role of the telephone in agricultural transactions. Looking for buyers for its product and for its supply of inputs including hired labor has an important place in the calls received or issued.

Pineapple production is more export oriented. To ensure the quality required for products exported, it is essential for producers to comply with the recommendations in this industry such as the respect of a specific crop management. The need for information is imperative in this case and use the mobile phone is tapped. Table 2 shows the perception of farmers on the use of mobile phones and facilities obtained in agricultural transactions as they are engaged in export of pineapple, compared to the previous situation (situation before the use of mobile phone for such activities).

The use of cell phone saves time and money to producers in the agricultural transactions. Table 3 provides an illustration of time and money saved with mobile phone use. The use of mobile phone during a

Table 2. Farmers' Perception of the use of mobile phones

Comparison criteria	Frequencies	Percent
<i>Use of mobile for input acquisition compare with before</i>		
Lower	11	10,4
Same	45	42,4
Higher	50	47,2
<i>Use of mobile for crop/livestock marketing compare with before</i>		
Lower	7	6,7
Same	38	36,2
Higher	60	57,1

Table 3. Saving time and money with the use of mobile phone

Profit	Size	Mode	Quartile		
			25	50	75
How much savings in time (minutes) did you make the last time you used the mobile phone for agric transactions	103	30	30	45	60
How much savings in cost(CFA) did you make the last time you used the mobile phone for agric transactions	103	2000	500	1500	3000

transaction saves producers, according to the survey sample, about an hour to devote to other activities. The use of mobile phone to save time has already been shown by de Silva and Zainudeen in 2006. Also, do they earn in travel costs with the use of mobile phone.

Cell phone use intensity impact on pineapple trade

Table 4 shows the propensity score of the intensity of the use of mobile phone on agricultural transactions among pineapple producers. Experience in the use of mobile phone, distance to the nearest local market, distance to the nearest center where most inputs are purchased, and distance from the center of the nearest electricity discriminate users from non users in the intensity of mobile phone use. The graph of the "common support" (Figure 1) shows that the histograms of estimated propensity scores densities for users and non users of mobile phones overlap, which reassures that statistically treated and untreated individuals are comparable.

Assessing the impact of the use of mobile phone was made of three results: transaction costs, the selling price of pineapple and producers' income.

Based on three different algorithms (Radius, Kernel and Neighbor), the average effects of treatments on the intensity of mobile phone use for agricultural transactions on the three outcomes are estimated and presented in Table 5. The critical level of hidden bias in Table 5 is reported for significant effects, such as advocated by

Hujer et al. (2004). The results are mostly insensitive to hidden bias calculated. For example, for the impact of the intensity of the use of mobile phone on the income from crop production in the household, the sensitivity analysis suggests that at a level of $\Gamma = 1.75$, the causal involvement of significant impact could be critical. This value implies that if the producers who have the same vector Z (characteristics) differ in their ratings of mobile phone use by a factor of 75%, the effect on income may be debatable.

There is no significant evidence that mobile phone use by producers of pineapple reduces transaction costs. However, it appears that the use of mobile phones has a significant effect on the selling price of pineapple and the income derived by the household for crop production. Thus, with mobile phones, producers have more access to information and thereby increasing their ability to bargain and therefore the prices they receive (Steinen et al., 2007). This very significant effect on the price obtained and income confirms the results of Okello (2005) and, Okello and Swinton (2007) who found that the effect of market access for producers may be great for cash crops and valuable fruits.

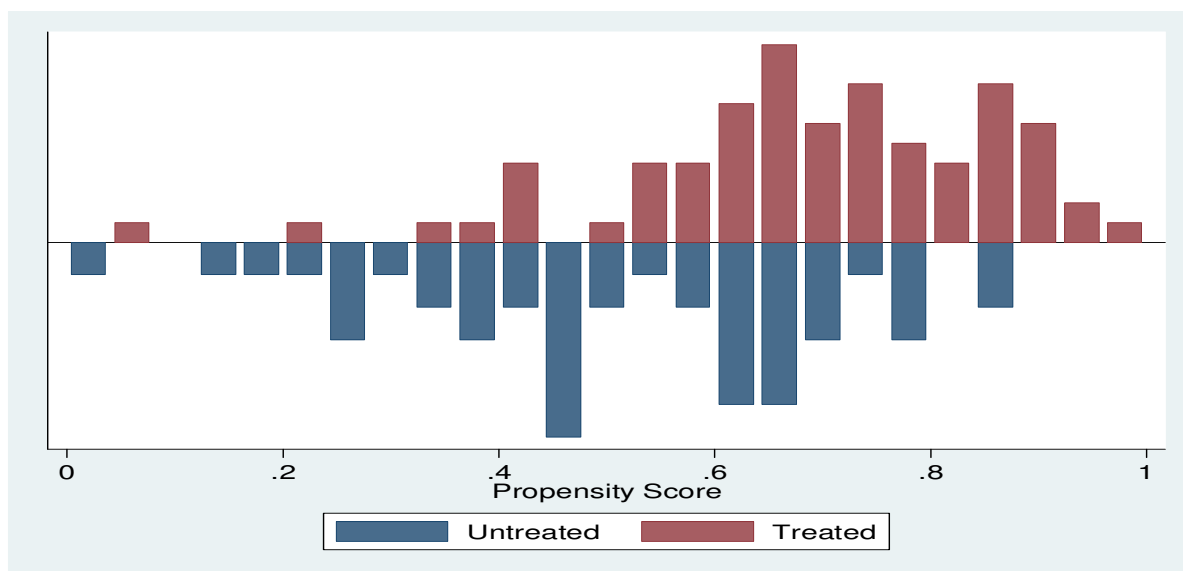
CONCLUDING REMARKS

The objective of this study is whether the use of cell phones by pineapple producers improves their access to market and income. From the investigations carried out

Table 4. The propensity score for the intensity of the use of mobile phone for agricultural transactions

Dependent Variables : Intensity of cell phone use (1=more than 10% of the call intended to produce/inputs traders ; 0= if No)				
mobtrader2	Coef.	Std. Err.	Z	P> z
Experience in crop production (year)	-0.133	0.355	-0.37	0.708
Age (year)	-0.221	0.174	-1.28	0.202
Age squared (year)	0.003	0.002	1.40	0.163
Experience in use of cell phone	-0.235	0.111	-2.13	0.033
Education in log form (year)	0.101	0.208	0.49	0.627
household size in log form	0.737	0.567	1.30	0.193
Experience in non agricultural activity (year)	-0.265	0.195	-1.36	0.175
Total land cropped (ha)	-0.004	0.016	-0.28	0.782
Total man power used in log form	-0.157	0.301	-0.52	0.602
Distance to nearest local market	-0.313	0.149	-2.10	0.036
Distance to nearest inputs provider centre	-0.170	0.101	-1.69	0.091
Distance to nearest electricity centre	0.289	0.146	1.98	0.048
Distance to nearest telephone centre (air time provider and repair)	-0.025	0.084	-0.30	0.767
Constant	6.531	3.218	2.03	0.042

N = 119; LR chi2(12) = 21.68; Prob > chi2 = 0.060; Log likelihood = -68.07; Pseudo R² = 0.14

**Figure 1.** Propensity score distribution and common support for propensity score estimation.

Treated on support indicates the individuals in the users' group who find a suitable match whereas treated off support indicates the individuals in the users' group who did not find suitable match

on the ground, it appears that the mobile phone is used by the producer for two main reasons. The first is to communicate with members of his family and some friends for social purposes. The second reason is to share with friends in the same occupation from which he

can obtain information, traders / buyers and sellers of pineapple input, and finally, workers recruited to work on the plantation. The results show that, during transactions, the use of cell phone saves time and allows the producer to save money which was used for multiple trips. The

Table 5. Average treatment effects of ICT use for farming and sensitivity analysis

Matching algorithm	Outcome	ATT		Critical level of hidden bias (Γ)
Radius	Transaction costs in log form (FCFA)	0.192	(1.44)	-
	Price in log form (FCFA/Kg)	0.096**	(2.06)	2.00-2.05
	Household crop income in log form(FCFA)	0.461**	(2.00)	1.75-1.80
Kernel	Transaction costs in log form (FCFA)	0.197	(1.46)	-
	Price in log form (FCFA/Kg)	0.094**	(2.08)	2.00-2.05
	Household crop income in log form(FCFA)	0.450**	(1.99)	1.75-1.80
Nearest neighbor	Transaction costs in log form (FCFA)	0.211	(1.53)	-
	Price in log form (FCFA/Kg)	0.121***	(2.60)	2.00-2.05
	Household crop income in log form(FCFA)	0.508***	(2.64)	1.75-1.80

Number in parentheses is t-stat; Significance at 1%, 5%, and 10% levels is denoted respectively by ***, **, *.

N Treated = 74; N controls = 45.

mobile phone facilitates transactions and provides access on time, to relevant information. Thus, its use allows pineapple producers to sell their produce at a good price and significantly improve their income. The use of information and communication technology thus appears important and recommended in the production of cash crops, for which the need for information is of paramount importance. Therefore, we suggest that it is implemented, the conditions for the adoption and general use of ICT in rural areas.

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