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Impact of Information and Communication Technology-Based Market Information Services on Smallholder Farm Input Use and Productivity: The Case of Kenya

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Summary. — Information asymmetry has traditionally constrained smallholder farmers' access to markets, consequently limiting their adoption of modern technologies and farm productivity. Improved smallholder farmers' access to markets via the recent Information and Communication Technology (ICT) platforms has the potential to reverse this scenario. This study uses Propensity Score Matching (PSM) technique to evaluate the impact of an ICT-based market information services (MIS) project on farm input use and productivity in Kenya. It finds a positive and significant impact of the intervention on the use of seeds, fertilizers, land, and labor productivity. However, a negative impact on labor usage is found.

Key words — ICT, market access, propensity score matching, productivity, Kenya, Africa

1. INTRODUCTION

The importance of information for adequate functioning of markets has been a prominent concern in economic theory, tracing back to the seminal work of Stigler (1961) on the economics of information. In the late 1980s to early 1990s, many developing countries assisted by development partners, invested in Market Information Services (MIS) and other reforms to improve market linkage and subsequently, rural household incomes (Kizito, 2009). Various forms of MIS mainly emerged as accompanying measures to the Structural Adjustment Programs (SAPs) that targeted the liberalization of agricultural markets. Such interventions eliminated some of the barriers that curtailed the private sector from providing agricultural services. The private sector's participation in agricultural markets was expected to address smallholder farmers' problems of access to input and output markets (Okello & Ndirangu, 2010).

Nevertheless, situations of information asymmetry still prevail in most developing countries (Svensson & Yanagizawa, 2008). As a result, information-related problems such as moral hazard and adverse selection (see Akerlof, 1970; Quiggin, Karaggiannis, & Stanton, 1993) that in turn increase transaction costs, hence limiting market participation by some farmers linger on (Fafchamps & Hill, 2005; Omamo, 1998; Okello, Kirui, Njiraini, & Gitonga, 2012). Limited access to capital or credit, among myriad other constraints also impede smallholder farmers' access to inputs and high-end markets for their output (Okello, 2010). This is despite their significant contribution to the economies of most developing countries. In Kenya for instance, smallholder farmers account for about 75% of the total agricultural output and provide virtually all the domestic food requirements of the nation (Kuyiah, Obare, Herrero, & Waithaka, 2006).

Constrained access to capital or credit and market often dampens farmers' incentives to use better production techniques such as yield augmenting inputs that have the potential to increase the productivity of their land holdings and enhance their access to high value markets. This has far-reaching implications: the low use of inputs in turn results in low farm productivity which curtails the transition from subsistence to commercial agriculture, hence perpetuating the confinement of smallholder farmers in the low-equilibrium poverty trap (Barrett, 2008). Such is the case in Kenya where productivity levels for most crops are below optimal due to poor market access, extension services, and low application of modern agricultural technologies (Government of Kenya, 2007).

The enhancement of agricultural productivity has, therefore, been a major focus of policy makers in Kenya due to the significant role of the agricultural sector in the country's economic development (Odhiambo & Nyangito, 2003). Thus, Information and Communication Technology (ICT)-based projects have been recently introduced as part of the strategies to overcome the low farm productivity and improve agricultural performance among smallholder farm households through improved market linkage. Such projects include DrumNet, Kenya Agricultural Commodity Exchange (KACE), Regional Agricultural Trade Intelligence Network (RATIN), National Livestock Market Information System (NLMIS), and M-farm. Similar initiatives outside Kenya comprise the Malawi Agricultural Commodity Exchange (MACE), Busoga Rural Open Source Development Initiative (BROSDI), and Women of Uganda Network (WOUGNET). Theoretically, it is expected that farmers who participate in

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such projects will tend to use the technical information acquired through them to adopt superior techniques of production, hence realize higher outputs.

In spite of the expected gains from accessing ICT-based MIS projects, few studies have provided empirical evidence of the impact of such projects, particularly in the developing country context. Notable exceptions include Aker (2008), Svensson and Yanagizawa (2008), Houghton (2009), Jensen (2010) and Okello (2010). Specifically, there is scanty empirical evidence of the impact of such projects on farm input use and productivity. The few studies that have attempted to provide empirical evidence of the impact of ICT-based MIS on agricultural productivity comprise Lio and Liu (2006) that was conducted at macro-level and applied Ordinary Least Squares (OLS) approach. The approach employed did not control for potential selection bias which is expected under the circumstances. Houghton (2009) also assessed the impact of mobile phones on agricultural productivity by employing micro-level data using Heckman two-stage regression. That study used cattle ownership as the proxy for measuring productivity gains, hence distinct from the present study. Finally, Kiiza, Pederson, and Lwasa (2011) evaluated the impact of ICT-based MIS on prices received by farmers and the intensity of adoption of improved maize seed in rural Uganda. This study is comparable in some aspects to that of Kiiza *et al.* (2011), but extends it by evaluating the impact of access to ICT-based MIS on the use of fertilizer, pesticides, farm manure, besides improved seed. Furthermore, it examines the impact of access to ICT-based MIS on land and labor productivity.

The rest of this paper is organized as follows. The next section provides a brief description of the ICT-based MIS project of focus. Section 3 presents the theoretical framework and the estimation procedure. In section 4, the results are presented and discussed, while section 5 concludes with a summary of the key findings and their policy implications.

2. THE STUDY CONTEXT

DrumNet was a project of a Non-Governmental Organization (NGO) called Pride Africa. It was established in Kenya in 2002 (World Bank, 2011). At the time of its design, smallholder farmers in Kirinyaga district in Central province, a horticultural export region in Kenya, were experiencing various constraints, including limited price information and export market opportunities, lack of reliable production contracts and limited access to credit (Ashraf, Gine, & Karlan, 2009). DrumNet was introduced to improve agricultural extension, access to credit, and provide marketing services to smallholder farmers, and ultimately increase their farm productivity and foster stronger market linkages and increase efficiency of farm operations (Gine, 2005). The project's coverage was later expanded to Bungoma and Migori districts in Western and Nyanza provinces. In Central province, the project mainly focused on smallholder farmers producing French beans and baby corn, while in Western and Nyanza provinces the target crop was sunflower. Project participants also produced other crops, besides the target crops.

The project was designed to provide a package of services to target farmers that were organized into farmer groups and closely resembled an outgrower scheme (Ashraf *et al.*, 2009). It developed a series of partnerships involving output buyers, a credit provider (commercial bank), several agro-input retailers, and smallholder farmers. All the transactions (credit access, production, and marketing) were fully integrated and closely monitored by DrumNet and mediated via an ICT platform that basically used mobile phones. The use of ICTs across the platform was intended to make the transactions between the partners efficient and cost-effective (Campaigne & Rausch, 2010).

The process of linking partners began with organizing individual farmers into farmer groups that then signed sales contracts with output buyers. These contracts allowed farmers to access credit from a partner bank (i.e., Equity Bank) and obtain farming inputs from a local, certified, designated agro-input retailer. At harvest, the contracted produce was collected, graded, and sold to the buyer at designated collection points. A successful transaction between the farmer and the buyer then triggered an automatic cash payment through a bank transfer. The transfer of cash payments to a farmer group bank account completed the transaction. A more detailed account of the project's operations is presented in Ashraf *et al.* (2009), World Bank (2011) and Okello, Ofwona-Adera, Mbatia, and Okello (2010).

3. THEORETICAL FRAMEWORK AND ESTIMATION PROCEDURE

(a) *Modeling participation decision and household welfare*

Following Ali and Abdulai (2010) and Becerril and Abdulai (2010), it is assumed that the decision to participate in the ICT-based MIS project is dichotomous, where participation only occurs when the expected utility with participation (U_{ip}) is greater than without participation (U_{iN}) i.e., (U_{ip}) > (U_{iN}). The difference between the utility with and without participation may be denoted as a latent variable R_i^*, such that $R_i^* = (U_{ip}) - (U_{iN}) > 0$ indicates that the utility with participation exceeds that without participation. The decision by a farmer to participate or not to participate in the new ICT-based MIS project is dependent on farm, as well as farmer characteristics. Hence, it relies on each farmer's self-selection rather than random assignment. Assuming a risk neutral farmer who bases his or her production decisions on the criterion of maximizing the expected utility of his or her farm returns, the index function to assess participation in an ICT-based MIS project can be expressed as:

$$R_i^* = \gamma X_i + \varepsilon_i \quad (1)$$

where R_i^* is a latent variable signifying the difference between the utility derived from participation in the ICT-based MIS project and the utility from failure to participate in the project. The term γX_i represents an estimate of the difference in utility derived from participating in the ICT-based MIS project by employing the household and farm-level characteristics (X_i) as explanatory variables, whereas ε_i is an error term. Theoretically, participation in the ICT-based MIS project is expected to affect the demand for agricultural inputs such as fertilizer, purchased seed, manure, pesticides, herbicides, labor, as well as yields and net returns (π). The ICT-based MIS project model is expected to reduce information asymmetry and transaction costs among participating farmers by linking them to credit providers, agro-input dealers and buyers. To link the participation decision with these potential outcomes of participation in the ICT-based MIS project, we consider a risk neutral farmer that maximizes profits (π) subject to a competitive output and input market and a single output technology that is quasi-concave in a vector of variable inputs, w. It is however noteworthy that this is a strong assumption which might not hold in imperfect markets which are prevalent in