



Impacts of extension access and cooperative membership on technology adoption and household welfare



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ARTICLE INFO

Article history:

Received 18 August 2016

Received in revised form

23 April 2017

Accepted 29 June 2017

JEL classification:

Q16

I38

J54

Q13

Keywords:

Impact evaluation

Extension access

Cooperatives

Adoption

Welfare

Nigeria

ABSTRACT

This paper examines the impacts of access to extension services and cooperative membership on technology adoption, asset ownership and poverty using household-level data from rural Nigeria. Using different matching techniques and endogenous switching regression approach, we find that both extension access and cooperative membership have a positive and statistically significant effect on technology adoption and household welfare. Moreover, we find that both extension access and cooperative membership have heterogeneous impacts. In particular, we find evidence of a positive selection as the average treatment effects of extension access and cooperative membership are higher for farmers with the highest propensity to access extension and cooperative services. The impact of extension services on poverty reduction and of cooperatives on technology adoption is significantly stronger for smallholders with access to formal credit than for those without access. This implies that expanding rural financial markets can maximize the potential positive impacts of extension and cooperative services on farmers' productivity and welfare.

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1. Introduction

Adoption of improved agricultural technologies by smallholders is considered as the main pathway for breaking poverty trap. Applied correctly, adoption should, *ceteris paribus*, increase productivity and provide additional income to farmers. In this way, technology adoption can accelerate economic growth, create marketing opportunities, and help millions of farmers to move out of poverty. However, adoption rates for improved agricultural technologies have been rather disappointing and far from complete and proper identification of the main barriers of adoption remains a challenge (Shiferaw et al., 2008; Solomon et al., 2010; Wossen et al.,

2015). Major identified causes of low adoption rates include supply-side constraints such as imperfect information and credit markets (Shiferaw et al., 2008; Suri, 2011; Wossen et al., 2015). Addressing information market imperfections can therefore serve as an important entry point for increasing adoption of agricultural technologies.

This paper focuses on extension access and cooperative membership which are key supply-side policy instruments to influence agricultural productivity in developing countries. Access to extension service enhances the adoption of improved agricultural technologies by reducing supply-side constraints that arise due to information market inefficiencies (Wossen et al., 2015). In particular, extension access facilitates adoption by exposing farmers to new technologies and by educating them about best farming and management practices (Anderson and Feder, 2007; Wossen et al., 2013). In addition to its direct effect on adoption, access to

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extension service affects welfare by helping farmers to reduce the gap between potential and actual yields (Anderson and Feder, 2007). However, extension access may also hinder adoption if extension workers exclude the poorest farmers or if they lack both the incentive and accountability needed to transfer reliable and timely information to smallholders (Davis, 2008; Jack, 2011). Although extension networks have been cited as the primary ways through which researchers and policymakers promote new and improved agricultural technologies, the evidence for their impact on adoption and welfare is rather mixed (Anderson and Feder, 2007; Davis et al., 2012).

The other well-documented constraint to the adoption of agricultural technologies is related to market inefficiencies, financial as well as input and output markets. In response to these market-related barriers, several farmer-controlled cooperatives have emerged in rural areas (Latynskiy and Berger, 2016). Cooperatives are widely regarded as an important institutional innovation that can help overcome the constraints that impede smallholders' access to market (Abebaw and Haile, 2013; Verhofstadt and Maertens, 2014; Ma and Abdulai, 2016). There are many pathways through which cooperatives may affect technology adoption and welfare. First, cooperatives can relax the liquidity constraint that farmers face by providing credit for members. Secondly, cooperatives affect adoption and welfare by providing market information and, thirdly, by potentially offering a better market price for their produce. Finally, by pooling different resources such as credit, information, and labour among members, cooperatives can create economies of scale and hence improve welfare.

Against this backdrop, this paper seeks to examine the impact of extension access and cooperative membership not only on adoption of improved agricultural technologies but also on household welfare outcomes. Whereas adoption of improved cassava varieties serves as a measure of the adoption of agricultural technology, we use asset ownership, consumption expenditure, and the progress out of poverty index (PPI) as a measure of welfare outcomes. Evaluating the impact of extension access and cooperative membership on technology adoption and welfare outcomes is nontrivial as in other social programs, because of endogenous program placements. We therefore employed alternative econometric techniques including propensity score matching and endogenous switching regression methods to address the endogeneity bias problem. By focusing on a country that heavily relies on cassava, this paper uses empirical data to identify the causal effects of access to extension and cooperative services on the adoption of improved cassava varieties and household welfare. In doing so, the study provides not only new evidence on the impacts of extension access and cooperative membership on welfare outcomes but also on the heterogeneous treatment effects of such interventions. To the authors' knowledge, this paper is the first to provide a comprehensive assessment of extension access and cooperative membership effects on adoption and welfare outcomes in the context of Nigeria.

The remainder of the paper is organized as follows: Section 2 provides background information on the evolution of extension services and cooperatives and reviews the literature on the impacts of extension access and cooperative membership on technology adoption and household welfare. Section 3 presents data sources and the econometric strategy used for the empirical analysis. Section 4 presents the findings and discusses the results. Section 5 concludes the study, provides a list of open questions and discusses further research.

2. Context and related literature

Our study focuses on cassava production in Nigeria, the largest cassava producer in the world. Cassava is the most widely

cultivated root crop in terms of area allocation and has the largest number of growers (FMANR, 2010; Abdoulaye et al., 2013). Cassava has been increasing in importance in recent years and is fast replacing yam and other traditional staple foods as a famine reserve and insurance crop against hunger (FAO and IFAD, 2005; FMANR, 2010). The crop is important not only as a food but also as a major source of income for rural households. As a cash crop, cassava generates income for the largest number of households compared with other staples (FAO and IFAD, 2005; FMANR, 2010); this justifies our focus on the crop. Improving agricultural productivity – in particular, cassava productivity – through an efficient extension advisory service is therefore central for poverty reduction efforts in Nigeria. Cognizant of this fact, different approaches and systems for extension service delivery have been implemented in an attempt to improve productivity and reduce rural poverty. For instance, until the late 1960s the extension service mainly targeted exportable commodities. However, this approach was reversed in the 1980s when the focus shifted towards food self-sufficiency as part of the Agricultural Development Projects (ADPs) program. This approach gave special attention to training and visit (T&V) that was favoured by many donors including the World Bank (FMARD, 2014). The services provided by ADPs include establishing demonstration farms; identifying lead farmers and providing them with information about improved farming practices; facilitating access to improved technology and inputs, such as improved seed varieties, fertilizer, crop chemicals and machinery services and helping lead farmers to train other farmers (Mogues et al., 2012). To date, T&V is still the dominant extension service delivery approach in Nigeria, albeit with some modifications and blending with participatory approaches by several NGOs in the agricultural sector (FMARD, 2014).

With the aim of improving the effectiveness and efficiency of the extension service, a policy of a Unified Agricultural Extension Service (UAES) was implemented in 1991. This program aimed at providing an 'efficient extension service through a single extension agent covering the whole farming system in a holistic manner. From 2008 onwards, the Government again revised the extension policy as part of the National Food Security Program (NFSP) to further improve efficiency through information and interventions based on communication technology (ICT) (FMARD, 2014). The new extension system was aimed at transforming agricultural extension service into a participatory, demand-driven, market-oriented, and ICT-driven service (FMARD, 2014).

In the context of sub-Saharan Africa (SSA), the role that extension access plays in technology transfer and household welfare has received considerable attention (Anderson and Feder, 2007; Davis, 2008; Davis et al., 2012). Empirical evidence has shown that institutional arrangements and public investment that improve agricultural extension play a crucial role in facilitating technology transfer for rural poor farmers (Anderson and Feder, 2007; Davis, 2008; Dercon et al., 2009; Ito et al., 2012). For instance, Owens et al. (2003) reported a 15% gain in crop productivity due to extension access in rural Zimbabwe. Similarly, Dercon et al. (2009) showed that agricultural extension improved household welfare by reducing the incidence of poverty in rural Ethiopia. Their study highlighted the fact that receiving at least one extension visit reduced the incidence of poverty by 10 percentage points and increased consumption growth by 7 percentage points. In the context of Nigeria, Abdoulaye et al. (2013) found that farmers' proximity to change agents resulted in a higher level of awareness and the use of improved technologies. Similarly, Sodiya et al. (2007) reported a positive relationship between extension access and adoption of improved cassava varieties in Nigeria. Despite a plethora of empirical evidence on the effects of extension access in many developing countries, a comprehensive assessment of the

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