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The effects of telephone infrastructure on farmers' agricultural outputs in China

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ABSTRACT

This paper examines the effect of farmers' access to communication technologies (CTs) on farmers' agricultural output at the aggregate level in the People's Republic of China (P.R. China) based on panel data. The paper uses a dynamic Cobb–Douglas aggregate production function and the generalised method of moments (GMM) as estimation techniques to estimate the parameters of interests. The research findings are: the estimated effects (measured by elasticity) of teledensity on the provincial level agricultural output have been positive and statistically significant both in the short and long runs. In the long-run, the size of the effect is substantial: from 0.94 to 1.06. This implies that the agriculture sector of the P. R. China has some potentials to derive benefit from the use of CTs like telephone. Hence, the Chinese government should consider policy support to expand communication infrastructure for the farmers.

1. Introduction

Information and communication technolgy (ICT) is considered as a general purpose technology (Jovnovic and Rousseau, 2005) that can lead to "fundmental changes in the production process of those using new invention" (Basu and Fernald 2007, p. 148). It is also an infrastructure which is but different from infrastructures like roads and highway (Röller and Waverman, 2001). A large body of studies investigated the influence of ICTs on productivity[1] in manufacturing and service sectors at the aggregate level (see Cardona et al., 2013 for surveys). The central point of these studies was, the estimated effect (measured by elasticity) of ICT (measured by the expansion of the access to ICT) was positive. The effect of ICT on agriculture was assumed to be very substantial too (World Bank, 2011). Although such an assumption was supported by micro level researches (for instance, Ali and Kumar, 2011; Aker, 2010; Aker and Fafchamps, 2015; Mittal et al., 2010; Rashid and Islam, 2009), at the macro level the research evidence was inadequate. To the best of our knowledge, except Lio and Liu (2006) and Salim et al. (2016), no other study examined the influence of communication technologies (CTs) on agricultural output. The reason for inadequate research might be due to the fact that agriculture is a primary sector in an economy and the sector cannot reap benefit from increasing opportunities of CTs. Therefore, we aim to strengthen the existing body of literature by examining the effect of farmers' access to CTs on farmers' agricultural output at the aggregate level in the People's Republic of China. We have selected the Chinese agriculture for this study because the Food and Agriculture Organization (FAO) ranked the country's agriculture top in the world for its agricultural production in 2013 (Food and Agriculture Organization, 2013). Therefore, we presumed that it might be useful to test the hypothesis in an economy within the groups of developing countries. Because of inadequate research evidence, the development agencies claimed that the developing countries were adopting state-of-the-technology without realising the actual benefit from it (Van, 1999), including mobile telephone facilities (James, 2009). The findings of this study provide evidence that the

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[1] By the word 'productivity' this paper means a ratio between outputs and inputs. In economics terms, it is a value of output produced by using one unit of input holding other things constant. There are two types of productivity concepts: partial productivity and total factor productivity. This paper has used partial concept of productivity.

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agricultural sector is likely to reap benefit from the development of ICT facilities.

The remaining parts of this paper are structured as follows. Section 2 provides literature review about the Chinese agriculture. Section 3 describes data and specification of the model. Section 4 explains empirical strategies. Section 5 presents findings and discusses the results. This paper ends with conclusions and policy implications in Section 6.

2. Literature review

Neoclassical growth theory postulates a functional relationship between inputs and outputs where the technology is hidden in the function and technological changes affect productivity through two channels: total factor productivity and labour productivity (Lipsey et al., 2005).

ICT has two components: information technologies (ITs) and communication technolgies (CTs) (Bloom et al., 2009), and telephnone connectivity either through mobile phone or through land phone is inevitable outcome of the state-of-the art CTs. In the developing countries, due to decreasing relative price of mobile phones and services charges, uptake ratio of mobile telephones has become very high compared to the ratio in the developed countries. The uptake ratios of mobile telephone to fixed-line telephone in the developing countries were 180 and 840 in 2005 and 2013, respectively compared to 174 and 296 in the same year in the developed countries (International Telecommunication Union, 2011).[2] Consequently, people can afford mobile phone easily (Quibria et al., 2003). A large body of literature have examined the influence of mobile phone on farmer-level gains from agricultural-related activities in the developing countries, including the Chinese agriculture. However, to the best of our knowledge, except Lio and Liu (2006), no other study has examined the influence of CTs at the aggregate level (aggregate agricultural output).

Li and Zhang (2013) analysed growth in the Chinese agriculture empirically using data covering the period 1985–2010. They found the evidence of positive effects of two factors of production (inputs): chemical fertiliser and agriculture machineries; but found the negative effects of two factors of production: land and labour. The findings were different from the findings of some past studies which found the evidence of positive effects of conventional factors of production - land, labour, fertilizer, and agricultural machinery.

Fan and Pardey (1997) analysed the productivity in the Chinese agriculture using a data set drawn from eight provinces of the PR China. The researchers used inputs - land, labour, machinery, fertiliser, and research and development (R & D) expenditure to specify the aggregate production function in their study. They found the evidence of positive effects of the conventional inputs and R & D expenditures on productivity in agriculture. The effects of R & D expenditures were investigated empirically in other studies (e.g. Jin et al., 2010) too.

Liu and Wang (2005) investigated the roles of technological progress in total factor productivity in agriculture in the 1990s using panel data covering the period 1991–1999. The data were drawn from twenty-eight provinces. They used an augmented aggregate Cobb–Douglas production function and found the evidence of positive effects of technological progress (measured by time variable) on the Chinese agriculture during the period of study. Li and Zhang (1998) broadened the research interest and examined the role of education in agricultural productivity in China in 1990. This research found the evidence of positive influence of farmer's education level on their level of income. However, the role of education in agricultural production was debated widely in applied research (Reimers and Klasen, 2013). The debate mainly concentrated on the measurement of human capital. Some literature used average years of schooling to measure farmers' human capital and some literature used literacy rate, percentage share of primary, high school, college and university graduate in the data set.

Chen et al. (2008) investigated the determinants of total factor productivity in the Chinese agriculture using index number method, Data Envelopment Analysis (DEA) technique and regression analysis technique. This research found that the technical progress was the main driver of total factor productivity in the Chinese agriculture. They further showed that the effects of R & D, farmer's level of education, irrigation, rural electricity consumption and agricultural mechanization on total factor productivity were positive.

In sum, single-country studies on agricultural production have highlighted the influence of conventional agricultural inputs such as land, labour, agricultural machinery, fertiliser, irrigation, farmer's level of education, and R & D expenditure. However, a strong assumption of the previous studies is that these studies have assumed inputs are strictly exogenous in the static form of Cobb–Douglas production function; but literature have asserted that irrespective of any sector, inputs are not exogenous in any production function (Jiwattanakulpaisarn et al., 2010; Kangasniemi et al., 2012). Furthermore, production process in agriculture is not spontaneous, rather dynamic in nature, because current year's gain (or loss) in agriculture depends upon the last year's production. Therefore, there might be simultaneity problem of the static form of production function that inevitably causes endogeneity problem if it is not controlled accurately (Greene, 2000; Levinsohn and Petrin, 2003). The previous studies have ignored the implication of simultaneity in the production function. This study takes into account the ignored issues and thereafter examines the effects of access to the CT infrastructure on the agricultural output at the provincial-level in China. The main contribution of this research is, this paper has used a dynamic Cobb–Douglas production function and relaxed the assumptions regarding the use of inputs in the production function which are discussed in details at the end of the literature review sub-section.

3. Data description and model specification

The data used in this study are gathered from the International Food Policy Research Institute (IFPRI). The title of the dataset is 'Chinese government expenditure, growth, poverty, and infrastructure, 1952–2001' (International Food Policy Research Institute, 2012). IFPRI collected data from various sources such as China Statistical Yearbook (SSB, various years); China Rural Statistical Yearbook (SSB, various years); China Fixed Asset Investment Yearbook (various years); China Education Expenditure Statistical Yearbook (SSB, various years). The dataset was without precipitation data. We have supplemented the IFPRI data with the precipitation data collected from the Statistical Yearbook of China 1993–2001. Based on the availability of data, this study has selected data set covering the period 1994–2000 only. The study has used one dependent variable and ten explanatory variables. The agricultural GDP data are deflated by the consumer price index where 1980 is chosen as the base year. The index was obtained from the Chinese Statistical Yearbook 2000.

Dependent variable: The dependent variable of this study is provincial level agricultural gross domestic output (hereafter, was called agricultural GDP). This variable is selected following the previous studies (e.g. Fan and Pardey, 1997; Salim et al., 2016). The variable is measured in Chinese currency Yuan or RMB at a constant price.

[2] Authors have calculated based on ITU World Telecommunication/ICT Indicators database. To do the calculation total numbers for mobile telephony subscription is divided by the total number of fixed-line subscription (per 1000 inhabitants).

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