Chapter 15
Facilitating Inclusive Use of ICTs in Rural China

Jikun Huang, Lanlan Su, and Xinyu Liu

Abstract The usage of information and communication technologies (ICTs) is increasingly becoming an important driving force for transforming the rural economy in China. Using a unique nationally-representative household survey dataset in 2015–2019, this study documents the overall trends of internet access, computer and smartphone usage, and e-commerce adoption in rural China and examines the main factors affecting farmers' adoption of major ICTs. The results show that the increase in usage of ICTs has been impressive. Empirical analyses suggest that human capital, resource endowment, ICT infrastructure, and neighborhood influence are the main determinants of households' or individuals' adoption of ICTs. However, a digital divide has emerged across regions and among farmers. This study concludes with several policy implications for fostering rapid and inclusive usage of ICTs in rural areas in the coming digital era.

15.1 Introduction

Information and communication technologies (ICTs) have spread globally, but there is a large gap between developed and developing countries. According to 2018 data reported by the International Telecommunication Union (ITU 2018), globally, about 58% of households had internet access at home, almost half of all households had at least one computer, and 76% of the population owned at least one mobile phone. However, the percentages of households with internet access (85%) and a computer (83%) and individuals owning a mobile phone (92%) in developed countries were much higher than the corresponding numbers (47% for internet access, 36% for having a computer, and 73% for owning a mobile phone) in developing countries (ITU 2018). Furthermore, there is also a large gap between rural and urban areas in

J. Huang (✉) · L. Su · X. Liu
China Center for Agricultural Policy, School of Advanced Agricultural Sciences, Peking University, Beijing, China
e-mail: jkhuang.ccap@pku.edu.cn

J. P. Estudillo et al. (eds.), *Agricultural Development in Asia and Africa*, Emerging-Economy State and International Policy Studies,
https://doi.org/10.1007/978-981-19-5542-6_15

developing countries in terms of ICT diffusion (Nakasone et al. 2014; Deichmann et al. 2016).

China has also experienced a rapid expansion in ICTs and has made great efforts to reduce the gap between rural and urban areas since the early 2000s. Nationally, the internet penetration increased from 16% in 2007 to 70% in 2020. The number of internet users increased from 210 to 989 million, and mobile phone subscriptions rose from 50 to 986 million over the same period (CNNIC 2021). In 2007, the rural internet penetration rate was only 7%, much lower than the 26% urban internet penetration rate. By 2020, while the internet penetration rate (80%) in urban areas was about three times that in 2007, it was eight times in rural areas (56%) over the same period. Facilitating rural ICT development was included for the first time in the Five-Year Plan for the National Economic and Social Development (or the Tenth Five-Year Plan) that was released in 2001. After that, the central and local governments have increased investment in rural ICT infrastructure, broadband village construction, capacity building and training, and policy support for rural e-commerce (Ministry of Agriculture and Rural Affairs 2020).

Driven by the significant increase in internet penetration, e-commerce has also developed rapidly in China. For example, the value of online sales in rural areas rose from CNY 353 billion in 2015 to CNY 1,800 billion in 2020, accounting for about 15% of the national online retail value in 2020 (Ministry of Commerce 2021). In terms of agricultural products, the online retail value reached CNY 398 billion in 2019. Moreover, the Taobao Village model (with a total yearly turnover larger than CNY 10 million on the Taobao platform from operating 100 live online stores and 10% of local households running online stores) that started in 2009 had 5,425 villages in 2020 (AliResearch 2020). Although the share of Taobao Villages in 2020 was less than 1% of total villages (690,000 villages) in China, this share is expected to increase significantly in the future, given its rapid growth.

In the literature on the adoption of ICTs by rural households, there has been an increasing number of empirical studies based on household surveys in many countries. These studies show that human capital, household resources (e.g., access to land and credit, etc.), and local ICT infrastructure are major factors affecting farmers' adoption of ICTs (Aker and Mbiti 2010; Kikulwe et al. 2014; Ma et al. 2018) and e-commerce (Kabango and Asa 2015; Li et al. 2021; Liu et al. 2021). However, there are also concerns about potential inequality due to the uneven spread of ICTs (Guo and Chen 2011; Hartje and Hübler 2017; Leng et al. 2020; Liu et al. 2020; Li et al. 2021) across regions and among the population.

The overall goal of this study is to further examine the major factors affecting rural households' adoption of major ICTs in China. While this is similar to many existing studies, we contribute to the literature mainly in two areas. First, we use a unique dataset on ICT adoption from the primary household surveys (2015–2019) with nationally representative samples in rural China. Second, we pay particular attention to the inequality of ICT adoptions across regions and households within the same village. The results of this study have important policy implications for fostering inclusive usage of ICTs and e-commerce, not only in China but also in other developing countries.

The rest of this paper is organized as follows: Sect. 15.2 introduces the household survey datasets and documents the development trends of major ICTs and e-commerce in rural China. Sect. 15.3 describes the main factors that likely affect the adoption of major ICTs. Sect. 15.4 discusses the empirical models and estimation strategies used in this study, and Sect. 15.5 presents the estimation results. The last section concludes with several policy implications.

15.2 Data

15.2.1 Sampling Approach

To ensure that samples represent rural households in major agricultural production regions in China, we combined three household surveys that used stratified random sampling in ten provinces (Datasets 1a, 1b, and 1c) to form a nationally representative sample (Dataset 1). Dataset 1a covers Zhejiang, Hubei, Guangdong, Shaanxi, Sichuan, and Jiangxi provinces with survey data from 2015 to 2019. Dataset 1b covers Liaoning and Hebei provinces with survey data from 2015 to 2019. Dataset 1c covers Henan and Shandong provinces with survey data in 2015 and 2016. The locations of each surveyed county in the ten provinces are presented in Fig. 15.1.

Datasets 1a and 1b used the same stratified random sampling approach. In each of these eight provinces, all counties were arranged in descending order of gross value of industrial output (GVIO) per capita, then divided evenly into five groups in all provinces, except Jiangxi, which had 12 groups due to more research funding from this province. One county was randomly selected from each group (12 counties in Jiangxi and five counties in each of the other seven provinces). The same procedure was also applied to select two townships from each county based on GVIO per capita, except in Jiangxi, where three townships per county were selected. In each sampled township, one administrative village was randomly selected. Within each village, 20 households (but ten households in Jiangxi) were randomly selected. A total sample of 2,480 households ($1{,}400 = 20 \times 1 \times 2 \times 5 \times 7$ in the seven provinces and $1{,}080 = 10 \times 3 \times 3 \times 12$ in Jiangxi Province) were selected for the survey. The first wave of the survey was conducted in early 2017 with data from 2015 and 2016; the second wave for the same households was conducted at the end of 2019 with data from 2017–2019. In this study, a total of 2,526 households (1,451 in the seven provinces and 1,075 in Jiangxi Province) were actually surveyed. The slightly higher number in the actual survey sample than the designed sample is due to replacing several new households in 2019 for households surveyed in 2017 but could not be followed up in 2019.

Dataset 1c from Henan and Shandong also used a stratified random sampling approach but was based on the area of cultivated farmland per capita instead of GVIO. We ranked all counties' areas of cultivated land per capita in descending order, then all counties were divided evenly into three groups. One county was

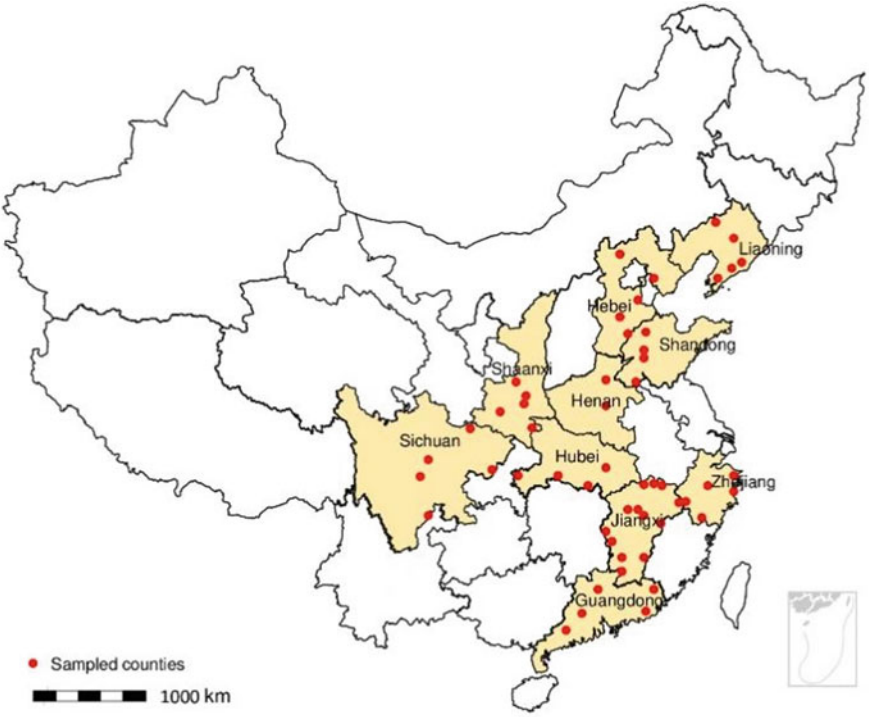

Fig. 15.1 Nationally representative surveys in ten provinces

randomly selected from each group. In each county, two townships were selected using the same procedures, which was also applied to select two villages from each township. Within each sampled village, ten households were randomly selected. A total of 240 households ($10 \times 2 \times 2 \times 3 \times 2$) were surveyed in 2017 for data from 2015 and 2016. Only one household did not complete the survey.

In all surveys, face-to-face interviews were conducted for each village and household. The survey mainly collected information on demographics, internet access, use of computers and smartphones, and agricultural production and marketing. Additionally, village leaders were interviewed to collect information on the infrastructure of ICTs in the village.

Because the surveyed samples differ among provinces, particularly between Jiangxi and the other seven provinces, and over time due to both follow-up and additional new samples, it was necessary to use a sample weight system for generating the whole sample mean and in the regression analysis. Specifically, for the statistics and regression analysis at the household level, the sample weights were calculated based on the number of households surveyed each year in each province. For the statistics and regression analysis at the individual level, the sample weights were calculated based on the number of individuals surveyed each year in each province.

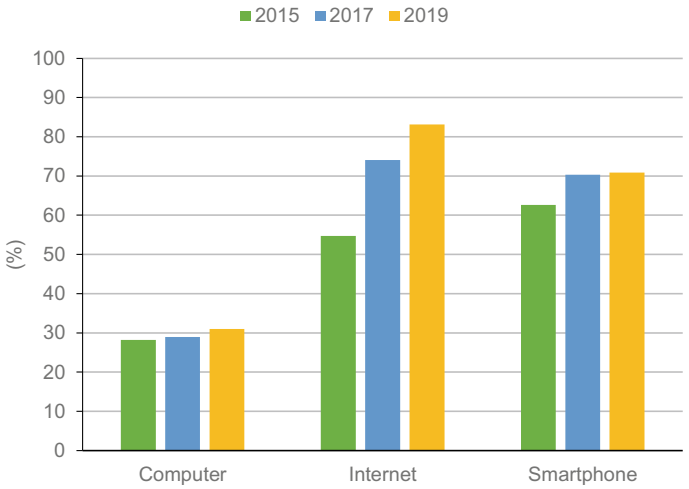

Fig. 15.2 Adoption of three major ICTs by rural households or individuals (2015–2019)

15.3 Adoption of Major ICTs by Rural Households and Individuals

Although there are many ICTs, the main ones used by rural households are internet access, computers, and smartphones. ICT application in e-commerce to sell agricultural products was also examined. Figure 15.2 shows the adoption of the three major ICTs in rural China from 2015 to 2019. Among the three ICTs, the percentage of households with internet access increased faster than households with a computer and individuals with smartphones. By 2019, the percentage of households with computers and access to the internet reached 30% and 83%, respectively; and the percentage of individuals with smartphones reached 71%. Our survey results are consistent with the statistics (measured for the whole population) reported by the China Internet Network Information Center (CNNIC 2021) if the internet and smartphone use in our data were also measured based on household population rather than households or individuals at least 16 years old.[1]

Figure 15.3 shows the adoption of three major ICTs by province from 2015 to 2019. While the adoption rates for all three ICTs had increased in nearly all provinces over time, the level of adoption of computers and internet access differ among the provinces. The percentage of individuals using smartphones did not vary significantly among the provinces.

Households with computers and internet access have increased over time, although this varied among the provinces. For example, even by 2019, less than one-third of rural households had a computer in Hebei, Liaoning, Jiangxi, Guangdong, Sichuan, and Shaanxi, indicating that there is still much room for the diffusion of computers

[1] The working age starts at 16 years according to the Labor Law in China.

Fig. 15.3 Adoption of three major ICTs by province in rural China, 2015–2019

in rural China. A slight decline in the number of households with a computer in Zhejiang and Hubei provinces in 2017 is due to adjusting the samples of these two provinces in the second round of surveys. In terms of internet access, the statistics show that its penetration rates in all surveyed provinces were close to or more than 70% in 2019. The growth rates in Hebei, Guangdong, and Liaoning provinces were relatively higher than those of other sampled provinces from 2015 to 2019.

Despite its rapid development, our survey data show that e-commerce is still not a common marketing channel for farmers to sell their products. In 2015, less than 1% of farmers had sold their products online. By 2019, although the number was more than double, only about 2% of them sold their products through e-commerce. When we asked farmers their most important reason for not using e-commence, about 67% responded that they lacked functional e-commerce skills. About 30% said they did not have storage facilities to keep their produce fresh. The rest said they lacked packaging and marketing skills and noted the high logistics cost. Due to the limited number of observations of farmers using e-commerce in our sample, this paper does not empirically analyze the factors affecting e-commerce adoption in rural China.

15.4 Variables and Descriptive Statistics

In general, variables reflecting the characteristics of individuals, villages, and households are used to explore the major factors that may affect farmers' ICT adoption. The definitions of all variables are shown in Table 15.1.

By comparing official statistics and our data presented in Tables 15.2 and 15.3, we confirm that our samples are representative of the national statistics in rural China. These include the household head's age, gender, education, farm size, and household size (NBSC 2020). According to official statistics, rural nonfarm labor was 41.5% in 2019 (NBSC 2020). Our data show that the percentage of individuals (at least 16 years old) who had nonfarm jobs was 42% in 2019 (Table 15.3).

Our surveyed villages seem to have better infrastructure. Nearly 20% of the sampled villages had at least one business office established by China Mobile, China Unicom, or China Telecom, the three major providers of mobile communication services in rural China. More importantly, the surveyed villages have achieved universal coverage of mobile phone services and broadband internet since 2016.

Table 15.2 shows the descriptive results of ICT adoption at the household level. Generally, there are significant differences in the observed characteristics between adopters and non-adopters of computers and the internet. On average, household heads who adopt the computer and the internet are younger, with more years of schooling, and have work experience in nonfarm sectors. Also, households with more family members, especially members who engage in non-agricultural jobs and cultivate more farmland, show a higher proportion of adopting it. Moreover, the villages' infrastructure and ICT adoption in their neighborhoods positively correlate with the households' adoption of the computer and internet.

Table 15.1 Definitions of all variables used in this study

Variables	Definition
ICTs adoption	
Computer	1 if the household has a computer, 0 otherwise
Internet	1 if the household can access the internet, 0 otherwise
Smartphone	1 if the individual (at least 16 years old) has a smartphone, 0 otherwise
Household head or individual characteristics	
Age	Age of household head or individual (years)
Education	Years of education (years)
Gender	1 if male, 0 otherwise
Nonfarm	1 if engaged in a nonfarm job, 0 otherwise
Household characteristics	
Others_nonfarm	Number of household members engaged in nonfarm jobs, excluding the household head or individuals at least 16 years old
Farm size	Area of cultivated land of the household (hectares)
Household size	Number of household members
Village characteristics	
Neighbor computer	Percentage of sampled households owning computers in the same village (%)
Neighbor internet	Percentage of sampled households with access to the internet in the same village (%)
Neighbor smartphone	Percentage of sampled individuals (at least 16 years old) owning smartphones in the same village (%)
Telecom	1 if there is at least one business office established by China Mobile or China Unicom, or China Telecom in the village, 0 otherwise

Table 15.3 shows the differences in the characteristics between smartphone adopters and non-adopters. Similar findings are shown in Table 15.2 on using computers and accessing the internet by household. There are significant differences in all characteristics (except the existence of a telecom operator) between smartphone adopters and non-adopters. Specifically, individuals with a smartphone are younger, better educated, and employed in nonfarm sectors than those without smartphones. Meanwhile, individuals with more family members engaging in nonfarm jobs and more land also tend to have smartphones. Moreover, the neighborhood effect is a potential enabling factor for individuals' usage of smartphones.

15.5 Model Specification and Estimation

A household's or an individual's adoption occurs when the expected utility of using ICTs (U_{1i}) is greater than the utility without using ICTs (U_{0i}) (i.e., $U_{1i} - U_{0i} > 0$).

Table 15.2 Descriptive statistics on computer and internet adoption at the household level

Variables	Mean	Computer (m = 0.28, SD = 0.45)			Internet (m = 0.74, SD = 0.44)		
Household head characteristics		Yes	No	*T*-test	Yes	No	*T*-test
Age	56.28	53.08	57.53	– 4.45***	54.82	60.56	– 5.74***
Education	6.79	7.86	6.37	1.49***	7.10	5.85	1.25***
Gender	0.98	0.99	0.98	0.01***	0.99	0.97	0.02***
Nonfarm	0.30	0.44	0.25	0.19***	0.36	0.12	0.24***
Household characteristics							
Others_nonfarm	0.92	0.95	0.61	0.34***	0.93	0.35	0.58***
Farm size	0.33	0.37	0.29	0.08***	0.35	0.30	0.05*
Household size	4.25	4.27	3.58	0.69***	4.86	3.29	1.57***
Village characteristics							
Neighbor computer	31.01	43.25	25.66	17.59***	32.03	26.35	5.68***
Neighbor internet	75.78	79.56	74.17	5.39***	81.04	60.01	21.03***
Neighbor smartphone	68.72	71.92	66.82	5.10***	70.12	62.77	7.35***
Telecom	0.20	0.23	0.18	0.05***	0.20	0.18	0.02

Note n = 13,570; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15.3 Descriptive statistics of smartphone usage at the individual level

		Smartphone (m = 0.70, SD = 0.46)		
Variables	Mean	Yes	No	*T*-test
Individual characteristics				
Age	45.62	39.55	59.77	–20.22***
Education	7.55	8.67	4.92	3.75***
Gender	0.52	0.55	0.46	0.09***
Nonfarm	0.42	0.56	0.09	0.47***
Household characteristics				
Others_nonfarm	0.92	1.06	0.59	0.47***
Farm size	0.33	0.34	0.31	0.03***
Household size	4.25	4.36	4.00	0.36***
Village characteristics				
Neighbor computer	31.01	32.27	28.06	4.21***
Neighbor internet	75.78	77.49	71.79	5.70***
Neighbor smartphone	68.72	70.65	64.21	6.44***
Telecom	0.20	0.21	0.18	0.03

Note n = 45,933; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The difference between the utility with and without ICT adoption may be denoted as a latent variable ICT_i^*, so that $ICT_i^* > 0$ indicates that the utility of ICT adoption exceeds the utility without adoption. While the utility difference cannot be directly observed, a household's or individual's propensity to adopt ICTs can be expressed in a linearized form as follows:

$$ICT_{ikt}^* = \beta_1 I_{it} + \beta_2 L_{it-1} + \beta_3 V_{it-1} + \varepsilon_{it} \tag{15.1}$$

$$ICT_{ikt} = 1[ICT_{ikt}^* \geq 0] \tag{15.2}$$

where ICT_{ikt} represents the ith household or individual which adopts the kth ICT ($k = 1$ or 2 or 3, representing computer use or access to the internet or having a smartphone) in year t. I_{it} is a vector of the household head characteristics when $k = 1$ or 2, and the individual characteristics when $k = 3$; the characteristics of the household head or individual include age, education, and gender. $L_{it\text{-}1}$ is a vector of the nonfarm job of the household head or individual and the household's characteristics in one-year lagged form. The household characteristics include the number of household members engaging in nonfarm jobs, farm size, and household size. $V_{it\text{-}1}$ is a vector of village characteristics in one-year lagged form, including the percentages of households having computers, access to the internet, and whether a telecom office operates in the village. 1[•] is an indicator function, denoting $ICT_{ikt} = 1$ if $ICT_{ikt}^* \geq 0$; otherwise, $ICT_{ikt} = 0$. $\beta_1, \beta_2, and \beta_3$ are the vectors of parameters to be estimated. ε_{it} is a random error term, which is assumed to be normally distributed.

The logit model estimates the above equations with and without the village fixed effect and with and without year dummies. The village fixed effect estimation can control for all time-invariant factors that may affect ICT adoption, and year dummies can control yearly specific impact. To correct the potential estimation bias caused by the different sample sizes among different provinces and over time, the sample weights adjusted by the observations of each province in each year are used in all regressions.

15.6 Empirical Results

Table 15.4 presents the estimation results based on a logit model on whether households have computer and internet access. To check the robustness of estimation results, two alternative specifications considering the year effect and the village fixed effect are estimated: column 2 and column 5 consider the year effect (a dummy for each year), and column 3 and column 6 consider both year effect and the village fixed effect. Generally, the results are consistent among the three estimations. In the rest of the discussion, we will focus on the estimation results in column 3 and column 6.

The estimation results provide strong evidence of the digital divide in age and education. The estimated parameters for the household head's age and education are

Table 15.4 Estimation results of households with computers and access to the internet

	Computer			Access to the Internet		
	(1)	(2)	(3)	(4)	(5)	(6)
Household head characteristics						
Age_{it}	− 0.007*** (0.001)	− 0.007*** (0.001)	− 0.009*** (0.001)	− 0.006*** (0.001)	− 0.007*** (0.001)	− 0.007*** (0.001)
$Education_{it}$	0.012*** (0.002)	0.012*** (0.002)	0.014*** (0.003)	0.009*** (0.001)	0.008*** (0.001)	0.009*** (0.001)
$Gender_{it}$	− 0.102 (0.104)	− 0.104 (0.103)	− 0.118 (0.116)	− 0.009 (0.010)	− 0.012 (0.010)	− 0.014 (0.010)
$Nonfarm_{it-1}$	− 0.033 (0.033)	− 0.037 (0.034)	− 0.048 (0.042)	0.032 (0.019)	0.019 (0.019)	0.016 (0.019)
Household characteristics						
$Others\_nonfarm_{it-1}$	0.040*** (0.005)	0.042*** (0.005)	0.042*** (0.004)	0.050*** (0.003)	0.051*** (0.003)	0.064*** (0.003)
Farm $size_{it-1}$	0.033*** (0.006)	0.033*** (0.006)	0.035*** (0.008)	0.019*** (0.003)	0.017*** (0.002)	0.035*** (0.005)
Household $size_{it-1}$	0.005 (0.005)	0.005 (0.005)	0.017** (0.007)	0.021*** (0.004)	0.022*** (0.004)	0.018*** (0.005)
Village characteristics						
Neighbor $computer_{it-1}$	0.007*** (0.000)	0.008*** (0.000)	0.004*** (0.000)	− 0.000 (0.000)	− 0.000 (0.000)	0.002*** (0.000)
Neighbor $internet_{it-1}$	0.000 (0.000)	− 0.000 (0.000)	0.001 (0.000)	0.006*** (0.000)	0.006*** (0.000)	0.004*** (0.000)
$Telecom_{it-1}$	0.008 (0.017)	0.006 (0.016)	0.003 (0.008)	0.015** (0.005)	0.015** (0.005)	0.038*** (0.010)
Village fixed effect	No	No	Yes	No	No	Yes
Year dummies	No	Yes	Yes	No	Yes	Yes

Note n = 13,570; estimated parameters are marginal effects, standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

statistically significant ($p < 0.01$) for all alternative specifications (row 1 and row 2 in Table 15.4). A one-year increase in the household head's age reduces the probability of households using computers by 0.9% (column 3) and accessing the internet by 0.7% (column 6). One year more of schooling of a household head increases the probability of the household using a computer by 1.4% and access to the internet by 0.9%. These results are consistent with previous findings that younger and higher educated farmers are more likely to adopt ICTs (e.g., Aker and Mbiti 2010; Al-Hassan et al. 2013; Leng et al. 2020).

Table 15.4 also shows that nonfarm employment, farm size, and household size significantly affect the use of computers and the internet by rural households. Nonfarm employment positively affects the use of ICTs (row 5) which can be attributed to the benefits stemming from nonfarm employment, such as improving human capital, enhancing income, and extension of social network (Ma et al. 2018). However, it is interesting to note that the nonfarm employment of the household head does not affect the household's use of the computer and internet (row 4). This may reveal that a rural household's use of the computer and internet is mainly influenced by their children. Additionally, households with more cultivated land are more likely to have computer and internet access. This may be because farmers operating more land have a stronger motivation to improve the efficiency of agricultural production through good use of ICTs (Aker 2011), or they can afford to buy computers and get access to the internet more (Kabango and Asa 2015).

The estimated parameters show that the intensity of using the computer (or internet) by the other households in the village has a significant positive effect on the household's use of the computer (or internet) (rows 8 and 9). These results provide strong evidence for the existence of neighborhood effects and social learning relating to the adoption of ICTs among rural households. Finally, the effect of the presence of a telecom office on households' access to the internet is significantly positive. This indicates that the mobile infrastructure in the villages lays the foundation for the diffusion of the internet in rural areas.

Table 15.5 reports the estimation results of individuals who had smartphones. Similar to the findings of households' usage of the computer and internet, age and education of individuals, nonfarm employment of other family members, farm size of the household, and percentage of farmers who have computers and smartphones within the whole village all have a significant effect on individuals' smartphone use. In addition, the differences between males' and females' smartphone use and those with and without nonfarm experience were also confirmed.

Specifically, on average, the probability of males using smartphones is 5.6% higher than that of females (row 3). Compared to those who do not engage in nonfarm jobs, employment in nonfarm sectors leads to an 8%–9% increase in using smartphones (row 4).

Table 15.5 Estimation results of individuals with smartphones

	(1)	(2)	(3)
Individual characteristics			
Age_{it}	– 0.011*** (0.000)	– 0.011*** (0.000)	– 0.012*** (0.000)
Education_{it}	0.015*** (0.001)	0.014*** (0.001)	0.015*** (0.001)
Gender_{it}	0.054*** (0.008)	0.055*** (0.008)	0.056*** (0.008)
Nonfarm_{it-1}	0.096*** (0.002)	0.089*** (0.002)	0.080*** (0.002)
Household characteristics			
$\text{Others\_nonfarm}_{it-1}$	0.006* (0.003)	0.007** (0.003)	0.015*** (0.004)
Farm size_{it-1}	0.008*** (0.002)	0.009*** (0.001)	0.010*** (0.002)
$\text{Household size}_{it-1}$	– 0.006* (0.003)	– 0.006* (0.003)	– 0.008 (0.005)
Village characteristics			
$\text{Neighbor computer}_{it-1}$	0.000 (0.000)	0.000 (0.000)	0.001** (0.000)
$\text{Neighbor smartphone}_{it-1}$	0.005*** (0.000)	0.005*** (0.000)	0.005*** (0.000)
Telecom_{it-1}	0.014*** (0.004)	0.013*** (0.004)	0.008** (0.003)
Village fixed effect	No	No	Yes
Year dummies	No	Yes	Yes

Note n = 45,933; estimated parameters are marginal effects, standard errors in parentheses; * $p <$ 0.10, ** $p < 0.05$, *** $p < 0.01$

15.7 Concluding Remarks

Using a nationally-representative household survey dataset covering 2015–2019, we document the trends of ICT usage in the past five years in rural China, empirically test the main factors affecting farmers' usage of ICTs, and discuss the inequality issues of digital technology adoption in rural China.

The results show that, even though the increase in ICT adoption has been impressive, there is still plenty of room for ICT penetration (particularly computers) in rural China. While e-commerce is emerging and clustering in some economically-developed regions, the average adoption of e-commerce for rural households in China is still very limited. Thus, a digital divide has emerged in rural China.

The econometrical results suggest that human capital (e.g., age, education); resource endowment (e.g., farm size and nonfarm employment); ICT infrastructure; and neighborhood influence are the main determinants explaining a household's or individual's adoption of ICTs.

The results of this study have several policy implications. First, while the spread of ICTs and e-commerce has been rapid and is expected to reshape agriculture and rural development in the future, a more inclusive development strategy should be pursued now. Digital technology can be driven by market forces and further accelerate the diffusion of ICTs in rural areas in the future. Still, without the policies and investment to support those left behind in using digital technology, new inequality

will occur in rural areas in the digital era. Second, more support should be provided to disadvantaged rural households and farmers through skills training, social network improvement, farm size expansion of the smallholders, and other capacity-building programs. Particular attention should be given to the older and less educated farmers and those in the less developed regions. Last but not least, investment in ICT infrastructure, enhancement of postharvest facilities, and improvement in logistics for e-commerce in rural, particularly in less developed rural areas, are essential to advance equality in the course of ICT diffusion.

Recollections of Professor Keijiro Otsuka

It is my great honor to participate in this Festschrift to recognize Professor Keijiro Otsuka's contribution to development economics. I first met him in 1989 when I was a PhD student at the International Rice Research Institute. Since then, we have closely kept in touch through various academic activities and conferences. He has also served as an Academic Advisory Committee Member of the China Center for Agricultural Policy (CCAP) and has provided constant support for our research programs since CCAP was launched in 1995. His works on the adoption and impacts of agricultural technology in developing countries have significantly contributed to our understanding of the roles of technology and policy in agricultural development. Thus, I decided to write this paper on facilitating the inclusive use of ICT in rural China, one of the major areas I have worked on recently.

— *Jikun Huang.*

References

Aker JC (2011) Dial "A" for agriculture: a review of information and communication technologies for agricultural extension in developing countries. Agric Econ 42:631–647

Aker JC, Mbiti IM (2010) Mobile phones and economic development in Africa. J Econ Perspect 24(3):207–232

AliResearch (2020) 1% change, 2020 China Taobao Village research report. http://www.aliresearch.com/ch/information/informationdetails?articleCode=126860487966199808&typ

Al-Hassan RM, Egyir IS, Abakah J (2013) Farm household-level impacts of information communication technology (ICT)-based agricultural market information in Ghana. J Dev Agric Econ 5(4):161–167

China Internet Network Information Center (CNNIC) (2021) The 47th china statistical report on internet development. http://www.cac.gov.cn/2021-02/03/c_1613923423079314.htm

Deichmann, U, Aparajita, G, Deepak, M (2016) Will digital technologies transform agriculture in developing countries. World Bank Policy Research Working Paper. No. 7669. World Bank, Washington, DC

Guo Y, Chen P (2011) Digital divide and social cleavage: case studies of ICT usage among peasants in contemporary China. China Q 207:580–599

Hartje R, Hübler M (2017) Smartphones support smart labour. Appl Econ Lett 24:467–471

ITU (International Telecommunication Union) (2018) Measuring the information society: International Telecommunication Union annual report. ITU, Geneva

Kabango CM, Asa AR (2015) Factors influencing e-commerce development: implications for the developing countries. Int J Econ Dev 1(1):64–72

Kikulwe EM, Fischer E, Qaim M (2014) Mobile money, smallholder farmers, and household welfare in Kenya. PLoS ONE 9(10):e109804
Leng C, Ma W, Tang J, Zhu Z (2020) ICT adoption and income diversification among rural households in China. Appl Econ 52(33):3614–3628
Li XK, Guo HD, Jin SQ, Ma WL, Zeng YW (2021) Do farmers gain internet dividends from e-commerce adoption? Evidence from China. Food Policy 3:102024
Liu M, Min S, Ma W, Liu T (2021) The adoption and impact of e-commerce in rural China: application of an endogenous switching regression model. J Rural Stud 83:106–116
Liu M, Zhang Q, Gao S, Huang JK (2020) The spatial aggregation of rural e-commerce in China: an empirical investigation into Taobao villages. J Rural Stud 80:403–417
Ma W, Grafton RQ, Renwick A (2018) Smartphone use and income growth in rural China: empirical results and policy implications. J Electron Commer Res 20(4):713–736
Ministry of Agriculture and Rural Affairs of China (2020) Expert advisory committee on agricultural and rural informatization, digital village development report of China in 2020. http://www.cqxumu.com/upload/2020/11/637423294227055808.pdf
Ministry of Commerce of China (2021) Person in charge of the E-commerce department of the ministry of commerce talks about the development of online retail market in 2020 in China. http://www.mofcom.gov.cn/article/resume/n/202102/20210203036186.shtml
Nakasone E, Torero M, Minten B (2014) The power of information: the ICT revolution in agricultural development. Annu Rev Resour Economics 6:533–550
National Bureau of Statistics of China (NBSC) (2020) China Rural Statistical Yearbook 2020. China Statistics Press, Beijing