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Infrastructure and regional economic development in rural China

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Abstract

Infrastructure affects rural development through many channels, such as improved agricultural productivity, increased rural nonfarm employment, and rural migration into urban sectors. However, the role of infrastructure has not been paid enough attention in the literature due to lack of reliable data on various infrastructure indicators. By using newly available detailed data on rural infrastructure from the Agricultural Census and other official sources, this paper uses a traditional source accounting approach to identify the specific role of rural infrastructure and other public capital in explaining productivity difference among regions, throwing new lights on how to allocate limited public resources for both growth and regional equity purposes.

JEL classification: H54; O47; O53; R11
Keywords: Chinese agriculture; Census; Infrastructure; Regional development

1. Introduction

Rapid growth in Chinese agriculture after the reforms has triggered numerous studies to analyze the sources of the rapid growth. These studies include Fan (1990, 1991), Fan and Pardey (1997), Huang and Rozelle (1996), Lin (1992), McMillan, Whalley, and Zhu (1989), and Zhang and Carter (1997). Most of these studies attempted to analyze the impact of institutional changes and the increased use of inputs on production growth during the reform period from the end of the 1970s to the beginning of the 1990s.

Fan and Pardey (1997) and Fan (2000) were among the first to point out that omitted variables, such as research and development (R&D) investment would bias the estimate of the effect of institutional change. To address this concern, they included a research stock

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variable in the production function to account for the contribution of R&D investment to rapid production growth, in addition to the increased use of inputs and institutional changes. They found that by ignoring the R&D variable in the production function estimation, the effects of institutional change would be overestimated to a large extent.

In addition to R&D investment, government investments in roads, electrification, education, and other public investment in rural areas may have also contributed to the rapid growth in agricultural production. It is highly likely that omitting these variables will bias the estimates of the production function for Chinese agriculture as well.

One of the most important features in rural China is the rapid development of rural nonfarm economies since the economic reform in 1978. But very few have analyzed the sources of growth in this sector. The only exception is Fan, Zhang, and Robinson (2003), who decomposed the growth in the nonfarm sector into growth in labor and capital. But they failed to include public capital as an input in their source accounting, partly due to the lack of reliable public capital data.

Associated with the rapid economic growth, regional disparity in productivity has also increased for China for the last two decades. The regional difference in productivity is a major determinant of income disparity, an increasing concern by policymakers and many scholars alike. The uneven regional development in nonfarm activities, particularly in the nonfarm sector, has been regarded as one major driving force behind the changes in rural regional inequality (Rozelle, 1994; Zhang & Fan, 2004). However, despite a large body of literature on the sources of growth, few studies have attempted to account for the sources of regional difference in productivity of both the agricultural and nonfarm sectors (one exception is Fan, 1990), and no studies have systematically assessed the roles of public investment in such differences in regional development.

The motivation of this study is to include these public investment variables that are newly available from the Census to estimate the production functions for both agricultural and nonagricultural economies in rural China and to decompose the sources of difference in productivity among regions. In particular, the specific role of infrastructure in explaining the difference in productivity among regions will be evaluated. There are two major advantages in using the Agricultural Census data. First, the census reports detailed infrastructure information at the country level, which is more disaggregate than the provincial level data commonly seen in the official statistical yearbooks. Second, the arable land area and labor force data are more accurately measured than the previous official sources (Ash & Edmonds, 1998; Smil, 1999).

The paper is organized as follows: Section 2 reviews the regional distribution of public capital in rural China. Section 3 develops a conceptual framework and model for the purpose of our analysis. Section 4 describes the data and Section 5 discusses our estimated results. We conclude the paper, and point out the limitations of the current study and future research directions in the Section 6.

2. Regional dimension of rural infrastructure

The Agricultural Census provides a unique opportunity to analyze the regional dimension of rural infrastructure in China. Table 1 presents the selected infrastructure indicators by

Table 1
Regional difference in rural infrastructure (1996)

Province	Road density			Electricity use	Rural telephone	
	km/10,000 km^2	km/10,000 labor	km/10,000 person	kW/person	Set/10,000 labor	Set/10,000 people
National	1679	28.7	18.4	260	303	283
Beijing	6310	48	28	709	1024	933
Tianjin	5258	27	17	844	625	555
Hebei	3021	18	11	252	222	207
Shanxi	3578	40	24	309	205	183
Inner Mongolia	484	64	42	150	229	199
Liaoning	2985	31	21	375	502	487
Jilin	2136	48	29	184	286	266
Heilongjiang	1200	54	35	177	388	345
Shanghai	17676	36	26	1771	2767	2760
Jiangsu	6863	19	13	453	604	573
Zhejiang	3505	15	10	525	596	582
Anhui	4905	20	13	113	160	156
Fujian	4305	35	21	383	735	594
Jiangxi	3529	29	19	115	109	102
Shandong	6358	21	14	287	242	206
Henan	4382	15	9	195	111	106
Hubei	4199	31	20	182	319	296
Hunan	4633	30	20	129	171	160
Guangdong	3843	25	14	625	1258	1222
Guangxi	2287	24	15	114	97	91
Hainan		51	29	63	163	158
Chongqing		22	16	159	121	111
Sichuan	2050	25	17	165	88	74
Guizhou	3172	29	18	78	54	42
Yunnan	2840	51	32	268	108	96
Tibet	344	339	199	22	65	54
Shaanxi	3210	37	23	172	101	95
Gansu	1300	42	26	190	81	71
Qinghai	207	72	46	273	247	244
Ningxia	1082	32	19	161	104	103
Xinjiang	277	90	52	159	172	166

When calculating road density, Hainan and Chongqing are included in Guangdong and Sichuan, respectively.
Source: calculated from the Agricultural Census.

province in 1996 when the census was conducted. First, we compare the newly available Census data with the official data which are published previously in various *China Statistical Yearbooks* by the State Statistical Bureau (SSB) or other government agencies. For road density, the Census reported 1679 km per 10,000 km^2, which is 34% higher than the official data, released from the Ministry of Transportation. Therefore, the data from the Ministry of Transportation may have understated the road density in rural areas. With respect to rural telephone, the Census reported 283 sets per 10,000 rural residents, which is 43% higher than 197 sets reported by SSB *Statistical Yearbook*. For rural electricity consumption, the Census reported 260 kW per person for 1996, while the SSB *Statistical Yearbook* reported 200 kW per person in rural China, a 30% difference.

In terms of the illiteracy rate, the Census data reported 14% for the rural population above the age of 7 years. This percentage is comparable to 11% in 1996 for agricultural labor reported by SSB's *Rural Statistical Yearbook, 1997*. The higher rate for the general population than agricultural labor may be due to the fact that the general population may have higher illiteracy rate than total labor force.

With respect to R&D spending and personnel, the data are not easily comparable. The Census reports such data only for the township level, while the official SSB or Ministry of Science and Technology reports the data above the county level. Nevertheless, the Census data provide unique and valuable information about science and technology at the lower level, which has never been reported before by other official sources.

Table 2
Percentage of rural population with different education levels (1996)

	Illiterate and semi-illiterate	Primary school	Junior middle school	Senior middle school	Special secondary school	College and above
National	14.01	42.15	38.04	5.07	0.57	0.16
Beijing	6.28	21.04	59.08	10.67	2.23	0.70
Tianjin	7.15	37.54	48.30	6.21	0.64	0.16
Hebei	10.03	39.11	43.87	6.45	0.44	0.09
Shanxi	8.81	35.74	48.41	6.20	0.62	0.22
Inner Mongolia	17.26	39.66	36.54	5.66	0.70	0.18
Liaoning	6.31	41.29	47.22	4.08	0.79	0.30
Jilin	8.27	45.47	40.75	4.56	0.77	0.19
Heilongjiang	8.67	43.54	41.95	4.77	0.84	0.24
Shanghai	13.83	28.39	49.38	6.37	1.44	0.60
Jiangsu	12.53	36.94	42.49	7.12	0.63	0.29
Zhejiang	13.85	44.26	36.30	5.07	0.37	0.15
Anhui	16.32	42.52	37.18	3.28	0.55	0.14
Fujian	7.01	51.53	35.83	4.86	0.61	0.16
Jiangxi	11.67	48.90	34.29	4.51	0.52	0.12
Shandong	9.80	40.65	43.09	5.63	0.66	0.15
Henan	13.57	33.41	46.26	6.13	0.49	0.14
Hubei	14.63	40.97	38.21	5.49	0.60	0.10
Hunan	9.65	43.76	39.42	6.37	0.65	0.15
Guangdong	7.93	42.87	41.39	6.81	0.75	0.24
Guangxi	10.42	47.98	35.77	5.00	0.71	0.12
Hainan	17.73	35.60	38.76	7.20	0.59	0.12
Chongqing	11.87	52.03	32.44	3.20	0.37	0.10
Sichuan	15.67	48.60	32.42	2.88	0.35	0.08
Guizhou	29.95	45.47	22.23	1.76	0.50	0.08
Yunnan	28.09	49.11	20.25	2.12	0.38	0.06
Tibet	75.71	22.93	1.21	0.09	0.05	0.01
Shaanxi	16.35	35.21	40.88	6.90	0.50	0.15
Gansu	35.57	34.40	24.12	5.25	0.51	0.15
Qinghai	46.04	31.82	19.10	2.77	0.21	0.06
Ningxia	31.16	33.37	29.68	4.70	0.86	0.22
Xinjiang	15.73	53.69	25.24	3.78	1.18	0.39

Source: calculated from the Agricultural Census.

The regional data reveal that the infrastructure development is highly correlated with the economic development level. Road density measured as the length of rural town roads per 10,000 km^2 has very large regional variation. If we exclude Beijing, Shanghai, and Tianjin in our analysis, Jiangsu has the highest road density, and Shandong has the second. Not surprisingly, Inner Mongolia, Tibet, Qinghai, and Xinjiang have the lowest road densities among all provinces. However, if we use the length of roads per rural resident, it is the western provinces or regions that per capita length of roads are the highest due to the relatively lower population density.

In terms of rural electricity, again, it is the coastal region that has the highest per capita consumption. For example, Guangdong, Jiangsu, and Zhejiang have more than 400 kW

Table 3
Science and technology personnel and expenses (1996)

	Number of S&T personnel (per 10,000 rural labor)	Number of S&T personnel (per 10,000 rural residents)	S&T spending in Yuan (per rural labor)	S&T spending in Yuan (per rural residents)
National	90.89	58.41	0.81	0.52
Beijing	200.16	115.69	0.90	0.52
Tianjin	253.67	155.73	0.38	0.23
Hebei	147.87	90.82	0.33	0.20
Shanxi	81.39	48.94	0.47	0.28
Inner Mongolia	344.24	224.39	0.24	0.16
Liaoning	88.93	58.88	1.38	0.92
Jilin	126.34	77.55	0.43	0.26
Heilongjiang	166.80	107.64	0.40	0.26
Shanghai	150.28	107.68	5.93	4.25
Jiangsu	81.50	55.64	1.12	0.77
Zhejiang	57.80	39.10	1.11	0.75
Anhui	54.56	35.04	0.46	0.30
Fujian	92.89	55.40	1.62	0.97
Jiangxi	47.77	30.90	0.22	0.14
Shandong	92.89	61.33	1.26	0.83
Henan	123.86	79.42	0.25	0.16
Hubei	84.61	54.11	0.77	0.49
Hunan	79.70	52.38	0.88	0.58
Guangdong	80.93	45.99	2.76	1.57
Guangxi	66.82	42.16	0.38	0.24
Hainan	143.37	82.08	1.10	0.63
Chongqing	37.32	26.49	0.39	0.28
Sichuan	64.45	44.86	0.91	0.64
Guizhou	27.10	17.12	0.43	0.27
Yunnan	35.05	22.32	0.61	0.39
Tibet	44.86	26.41	0.02	0.01
Shaanxi	104.83	64.08	0.15	0.09
Gansu	104.42	64.93	0.07	0.04
Qinghai	68.40	43.59	0.00	0.00
Ningxia	48.42	28.99	0.14	0.08
Xinjiang	345.98	199.60	0.24	0.14

Source: calculated from the Agricultural Census.

per person per year, while in Inner Mongolai, Tibet, Xinjiang, Guizhou, and surprisingly some central provinces, such as Anhui, Jiangxi, and Guangxi, per capita electricity consumption is less then 200 kW in 1996.

The difference in rural telephone possession is the largest among all types of rural infrastructure. In Guangdong, Jiangsu, Zhejiang, and Fujian, for every 10,000 residents, there are more than 500 telephone sets. But in Gansu, Tibet, Guizhou, Sichuan, and Guangxi, less than 100 sets are possessed for every 10,000 rural residents.

The education data reveals that in the western region, the Census reported much higher illiteracy rate than the official SSB *Rural Statistical Yearbook, 1997* (Table 2). For example, in Tibet and Qinghai, the Census recorded 76% and 46%, compared to 61% and 34% reported by *Rural Statistical Yearbook*, respectively. The gap in the education level between the eastern and western regions may have been higher than previously believed.

The Census data on science and technology personnel and spending uncovers a striking phenomenon (Table 3). It is the western region, for example Xinjiang, and Inner Mongolia, that have the highest ratios of science and technology personnel to rural population or labor. But in terms of science and technology spending, the region has the lowest. This implies that the science and technology personnel in less developed areas experience a severe shortage of operation funds compared to their eastern cohorts.

In summary, the Census data reveal a higher level of rural infrastructure development than previously thought. But it also uncovers a larger regional difference not only in the development of rural infrastructure, but also in the development of education and science and technology. This may explain why the western region has lagged behind despite rapid economic growth for the nation as a whole.

3. Conceptual framework and model

There have been numerous studies on the estimation of production functions for both agricultural and nonfarm sectors. One significant feature in these previous studies is the use of a single-equation approach. There are at least two disadvantages to this approach. First, many production determinants are generated from the same economic process. In other words, these variables are also endogenous variables, and ignoring this characteristic leads to biased estimates of the production functions. Second, certain economic variables affect the rural economy through multiple channels. For example, improved rural infrastructure will not only contribute growth in agricultural production, but also affect nonfarm production. It is very difficult to capture these different effects in a single-equation approach.

This study uses a simultaneous equations model to estimate the effects of rural infrastructure on both farm and nonfarm production.

$$\mathrm{AY} = f(\mathrm{LAND}, \mathrm{AGLABOR}, \mathrm{FERT}, \mathrm{MACH}, \mathrm{IR}, \mathrm{RD}, \mathrm{SCHY}, \mathrm{ROADS}, \mathrm{RTR}), \quad (1)$$

$$\mathrm{NAY} = f(\mathrm{RILABOR}, \mathrm{ELEC}, \mathrm{SCHY}, \mathrm{ROADS}, \mathrm{RTR}). \quad (2)$$

Eq. (1) models the agricultural production function. The dependent variable is gross agricultural output value (AY). Land (LAND), labor (AGLABOR), fertilizer (FERT), machinery (MACH) are included as conventional inputs. We include the following variables in the equation to capture the impact of technology, infrastructure and education on agricultural production: percentage of irrigated area in total cropped area (IR); number of agricultural researchers and extension staff (RD), road density (ROADS), number of rural telephone sets per thousand rural residents (RTR), and average years of schooling for population over the age of 7 years (SCHY).[1]

Eq. (2) is a production function for nonagricultural activities in rural areas. The dependent variable is gross value of the township and village enterprises (NAY). Labor input used in the nonfarm sector (RILABOR), infrastructure, and the labor education level are independent variables included in the function.[2] The electricity consumption (ELEC) is used to proxy for fixed and current capital used in the nonfarm sector.

Following Fan (1991), Fan and Pardey (1997), and Lin (1992), we use the traditional Cobb–Douglas form for both agricultural and nonfarm equations. In this form, the coefficients of independent variables are simply their elasticities with respect to the dependent variable. Regional dummies are also added to capture the impact of other factors that are not included in the equations.

To account for the sources of difference in productivity, we choose labor productivity in our analysis. Labor productivity is one of the most important indicators in economic development and is one of the major determinants of rural income. Following Fan (1990) and Hayami and Ruttan (1985), we use the following accounting formula:

$$\frac{\Delta \frac{Y}{L}}{\left(\frac{Y}{L}\right)_0} = \sum_i a_i \frac{\Delta \frac{X_i}{L}}{\left(\frac{X_i}{L}\right)_0} + \sum b_i \frac{\Delta P_i}{P_{i0}} \tag{3}$$

We use the average productivity at the national level $(Y/L)_0$ as our base for comparison, that is, we try to explain the difference in productivity between each region and the national average.[3] In Eq. (3), labor productivity difference is explained by the difference in the use of conventional inputs X_i, such as labor, land, fertilizer, and machinery, all measured on a per labor basis, and the difference in rural infrastructure, education, and science and technology capacity, denoted by P_i. If we divide every term on the right-hand side by the productivity difference (on the left-hand side), then the difference in productivity can be explained by the right-hand side variables in terms of percentages.

[1] The electricity variable is excluded mainly because it is highly correlated with road and telephone variables.

[2] Ideally, the capital variable should also be included in the function. But there is no such data available at the county level.

[3] This decomposition implicitly assumes a constant return to scale, that is, $\Sigma a_i = 1$. This assumption is not too realistic, as evidenced by Fan (1991) and Zhang and Carter (1997).

4. Data explanations

Our analysis is based on the county level. Most of infrastructure, education, and technology variables are available in the Agricultural Census. However, Agricultural Census does not report detailed information on agricultural and nonfarm output. Input uses are also not available. Therefore, in this analysis, we combine the Census data with the data from other SSB sources, such as *China Statistical Yearbooks* and *China's Rural Statistical Yearbooks*.

Agricultural output—agricultural output is measured as gross agricultural production value. The data is taken from the SSB official statistical source.

Nonfarm output—nonfarm output is measured as gross output value of township and village enterprises. The sources of the data are official SSB and Ministry of Agriculture publications.

Agricultural labor—agricultural labor is measured in stock terms as the number of persons engaged in agricultural production at the end of each year. They are taken from the Census.

Nonfarm labor—nonfarm labor is measured as number of employees in the township and village enterprises reported by the Agricultural Census.

Land—land is total arable land used for agricultural production. The data is taken form the Census.

Machinery—machinery input is measured as horsepower of machinery used in agricultural production. Because the Census does not report horsepower of machinery, we use the data from the SSB *Statistical Yearbook*.

Irrigation—irrigation services used in agriculture are proxied by the ratio of irrigated area. Because the published Census data do not report irrigated areas by county, we use the data from official sources of SSB and Ministry of Agriculture.

Fertilizer—it is measured as pure nutrients of chemical fertilizer. The data are taken from official sources of SSB and Ministry of Agriculture.

Roads—the length of township roads is reported by the Census. We divided the road length by the geographic areas to obtain the road density variable for our analysis.

Rural telephone—number of rural telephone sets is available from the Census. We use the number of telephone sets per 10,000 rural residents as our telephone variable.

Education—for the education variable, we use the percentage of population with different education levels to calculate the average years of schooling as our education variable, assuming 0 year for a person who is illiterate and semi-illiterate, 5 years with primary school education, 8 years with junior high-school education, 12 years with high-school education, 13 years with professional school education, and 16 years with college and above education. The Agricultural Census reports the percentages of population with different education levels who are above the age of 7.

Electricity consumption—electricity consumption in the nonfarm and agricultural sectors are reported by various issues of *China Rural Statistical Yearbooks*.

Science and technology—we use the number of science and technology personnel per 10,000 rural labor at the township level to represent the capacity of science and technology. The data are taken from the Census.

5. Results

Table 4 presents the estimated results of production functions for agriculture and nonfarm economies. Only 15 provinces or regions reported county level data in recent SSB provincial publications on the Agricultural Census. They are the following: Beijing, Tianjin, Shanxi, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Fujian, Jiangxi, Shandong, Hunan, Sichuan, Tibet, Shaanxi, and Ningxia. Although they cover roughly half of the provinces, the number of observations covers only 45% of the total number of counties. Therefore, the sample we used in our regression may not represent the whole of China.

Most coefficients in both agricultural and nonfarm production functions are statistically significant. The coefficients for conventional inputs in the agricultural production function, such as those for labor, land, fertilizer, and machinery, are in the same ranges of other studies (Fan, 1991; Fan & Pardey 1997; Zhang & Carter 1997). The labor and electricity variables (as a proxy for both fixed and current capitals) are also statistically significant in the nonfarm production function. One notable feature is that the coefficients for infrastructure and education variables are more significant in the nonfarm production equation than those in the agricultural production function. The fitness of both equations is exceptionally good with R^2 of .865 for the agricultural production function, and .813 for the nonfarm production function, despite the fact that cross-sectional data are used. The road variable in the nonfarm sector is insignificant due to its high correlation with the telephone variable; therefore, we drop it in the final estimation.

Table 5 presents the results of accounting. The numbers in parentheses are the difference in labor productivity level between each region and the national average. By

Table 4
Estimation of the equation system

	Agricultural output	Nonfarm output
Labor	0.262 (3.14)*	0.510 (16.84)*
Land	0.228 (8.47)*	
Fertilizer	0.150 (4.55)*	
Machinery (or electricity)	0.115 (6.34)*	0.480 (15.89)*
Research	0.104 (3.42)*	
Irrigation	0.260 (9.48)*	
Roads	0.032 (2.25)*	
Years of schooling	0.275 (1.81)*	0.792 (1.94)*
Telephone	0.056 (6.41)*	0.119 (6.51)*
R^2	.865	.813

Regional dummies are added to capture the provincial fixed effect, but the coefficients are not reported here. Total number of observations is 1104.

* Statistically significant at the 5% level.

Table 5
Accounting for the sources of labor productivity difference among regions

	Agriculture			Nonfarm			Total rural		
	Eastern	Central	Western	Eastern	Central	Western	Eastern	Central	Western
Productivity	100.00 (47.06)	100.00 (2.35)	100.00 (− 35.29)	100.00 (38.08)	100.00 (17.22)	100.00 (− 47.35)	100.00 (41.32)	100.00 (10.82)	100.00 (− 40.08)
Land	− 0.96	230.35	15.36				− 0.35	99.08	9.26
Fertilizer	7.45	46.27	10.63				2.69	19.90	6.41
Machinery	0.72	121.43	9.87	− 11.46	3.62	− 5.92	− 7.07	54.29	3.60
Irrigation	− 3.44	103.20	7.45				− 1.24	44.39	4.50
S&T	− 0.08	4.58	0.16				− 0.03	1.97	0.10
Roads	− 2.16	− 30.85	− 4.25	0.00	0.00	− 0.00	− 0.78	− 13.27	− 2.56
Telephone	20.50	− 210.14	10.66	53.83	− 61.02	16.88	41.82	− 125.16	13.13
Education	1.57	21.04	6.35	5.68	8.41	13.84	4.20	13.84	9.32
Residual	76.39	− 185.88	43.78	51.95	148.99	75.20	60.76	4.95	56.25

assuming this difference as 100%, we can explain the productivity difference in terms of the percentages by various factors shown in the rest of the rows in the table.[4]

The sources of difference in agricultural labor productivity vary sharply among regions. The higher labor productivity in the eastern region is primarily explained by higher fertilizer use, better infrastructure and the residual, which accounts for other missing variables. This residual is particularly large, implying that other factors, rather than those included in the equation, may have played an even bigger role in explaining its higher productivity. For the central region, higher productivity is mainly explained by more use of land per labor together with more fertilizer, machinery, and irrigation use. In the western region, the lower productivity is due to lower land use per labor (and therefore lower fertilizer use), poorer infrastructure and human capitals, and more limited science and technology capacity. The residual that has not been accounted by the variables included is also quite large, indicating other factors may have also contributed to lower productivity in the region.

For labor productivity in the nonfarm economy, roads and telephone together explained more than 60% of the difference between the regional and the national average in the eastern region. For the western region, nearly 40% of the productivity difference (lower than the national average) can be attributed to the physical infrastructure and lower education level. Large residual in the accounting for nonfarm productivity indicates that many other factors may also play a very important role in the nonfarm economy.

For the overall rural economy (aggregation of both agricultural and nonfarm economies), public capital, such as roads, telecommunication, and education, explained about 45% of the higher productivity in the eastern region. In the western region, lower public capital accounted for 26% of the lower productivity. In the central region, however, because its productivity is very close to the national level, it is not obvious how public capital has affected its productivity difference when compared to the national average.

[4] Because the development level in the Central region is close to the national average, the absolute difference in labor productivity is rather small. However, the decomposition analysis is based on relative percentage terms. Therefore, the results for the Central regions could be very sensitive.

6. Conclusions

The 1996 Agricultural Census provides a unique dataset to analyze various issues on rural development in China. In particular, it provides very detailed data on rural infrastructure, education, and science and technology. This paper is an early attempt to use this data set. Partly due to the limited access, the data we have is not complete, covering only 45% of the country. We will pursue more detailed and more thorough analyses once we have a complete data for all counties.

Despite the crudeness of the data and model we used, the results do shed new lights. First, rural infrastructure and education play a more important role in explaining the difference in rural nonfarm productivity than agricultural productivity. Because the rural nonfarm economy is a major determinant of rural income, investing more in rural infrastructure is key to an increase in overall income of the rural population. Second, the lower productivity in the western region is explained by its lower level of rural infrastructure, education, and science and technology. Therefore, improving both the level and efficiency of public capital in the west is a must to narrow its difference in productivity with other regions.

This research merely serves as a touchstone for future research. One of the urgent future research topics is to search different policy options to mobilize resources to support public good provisions for the less developed western region. Under the current fiscal decentralization scheme, financing infrastructure in regions with a small nonfarm sector faces a great challenge. Lack of local revenues is one of the major causes of underinvestment in the less developed western region.

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