Digital Economy, Farmers' Entrepreneurship and the Increase of Farmers'Income: Empirical Analysis Based on China Family Panel Studies(CFPS)

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Abstract. This paper systematically combed the relationship between digital economy, farmer entrepreneurship and the increase of farmers'income. Based on the systematic analysis of the mechanism of the impact of digital economy on farmers' income increase, this paper empirically analyzed the impact of digital economy on farmers' income increase in China based on the panel data of 25092 farmers of China family Panel Studies (CFPS) from 2014 to 2020 in 25 provinces and cities except Tibet, Qinghai, Xinjiang and Hainan, Ningxia, Neimenggu. The results show that digital economy not only directly promotes farmers' income increase, but also promotes farmers' income increase through the mechanism of improving farmers' entrepreneurial level. Additionally, the digital economy has obvious regional and age heterogeneity in promoting farmers' income increase.

Keywords: digital economy, the increase of farmers'income, farmers' entrepreneurship, CFPS, heterogeneity analysis.

1   Introduction

Digital economy has become the first new driving force for high-quality economic development in China. According to the White Paper on China's Digital Economy of 2022, China's digital economy has maintained a sound development momentum in the past five years, with the scale of the digital economy achieving a rapid growth of 54.1%. In 2021, the digital economy reached 42.4 trillion yuan, an increase of 8.2 percent over 2020. Meanwhile, the proportion of digital economy in GDP has reached 37.1%. Digital economy has become an important driving force for our economic development and a key support for constructing the new development pattern of double cycle. Domestic and foreign institutions and scholars measure digital economy mostly on the basis of digital economy connotation, Internet development and informatization level[1][2].

At the same time, the Chinese government is also paying close attention to issues related to agriculture, rural areas and farmers. Therefore, how to better develop the rural economy and promote the increase of peasants' incomes is still the focus of attention of scholars. Presently, the research on digital economy and farmers' income mainly focuses on the following two aspects. The first is study on the impact of digital economy

on farmers and farmers' income. Most domestic scholars show that the development of digital economy has a significant positive impact on farmers' income[3][4][5]. The second is the study on the impact of digital economy on the urban-rural income gap, which is mainly divided into the following two viewpoints: one is the digital economy has a linear impact on the urban-rural income gap[6], while the other is that the digital economy has a nonlinear impact on the urban-rural income gap[7].

Based on the learning and referring of the above literatures, it is easy to find the existing papers are mainly focused on the macro level, so this paper adopts mixed panel data in four phases, CFPS data of 2014, 2016, 2018 and 2020 and digital economy development index of each province to discuss the impact of digital economy on farmers' income based on the micro perspective of farmers' individual entrepreneurship, which can provide reference for Chinese digital economy and rural development related policy formulation.

2   Theoretical Analysis and Research Hypothesis

2.1   Direct mechanism of digital economy affecting farmers' income increase

The direct mechanism of digital economy to increase farmers' income is mainly the "digital divide" between urban and rural areas has narrowed significantly. Narrowing the information production gap is conducive to the application of information tools in agricultural production and the promotion of agricultural modernization, which will further improve the productivity of rural areas and thus promote the increase of farmers' income. Narrowing the information access gap is helpful to improve the speed of farmers' information acquisition and broaden the information receiving channels, reduce the information asymmetry, and thus generate cost effect and realize income increase. Narrowing the information use gap, especially the spread of applications with higher skill requirements, can increase farmers' income channels[8]. Therefore, hypothesis 1 is proposed in this paper.

H_1: Digital economy plays a positive role in promoting farmers' income increase.

2.2   Indirect mechanism of digital economy affecting farmers' income increase

The indirect mechanism of digital economy to increase farmers' income is mainly reflected in the following two aspects. First, digital technology has changed the traditional entrepreneurial process, but also provides farmers with a lot of outside entrepreneurial information. Rural entrepreneurs can make full use of the entrepreneurial learning platform provided by digital technology to improve the accumulation of entrepreneurial knowledge and better identify entrepreneurial opportunities. Second, the development of digital economy has increased the ways for farmers to obtain start-up funds. Farmers can obtain funds from formal financing channels such as the Internet and other new financial channels, thus expanding the financing channels for farmers to start businesses. High-quality self-employment of returning farmers can not only improve farmers' income in rural areas, but also narrow the income gap between farmers [9]. Therefore, hypothesis 2 is proposed in this paper.

H_2: Digital economy plays a positive role in promoting farmers' income by improving their entrepreneurial level.

3   Sample and Empirical Methodology

3.1   Sample

This paper adopts the data of China Family Panel Studies (CFPS) released by the China Social Science Research Center of Peking University. Based on the availability and matching of data, this paper integrated the information of the household tracking survey database and the personal database of the four periods in 2014, 2016, 2018 and 2020, and extracted the key variables matched by this research based on the rural samples in the urban and rural classification conducted by the National Bureau of Statistics. After the elimination of missing values, invalid values and repeated values, 25092 samples satisfying the research conditions were cleaned. Data related to the Digital Economy Development Index are collected from China Regional Economic Statistical Yearbook, China Science and Technology Statistical Yearbook, China Tertiary Industry Statistical Yearbook and Peking University Digital Financial Inclusion Index.

3.2   Variable measure

Measure of farmers' income
    This paper uses net household income per capita to measure the explained variable farmers' income.

Measure of digital economy
    This paper takes the development level of digital economy as explanatory variable. Based on the above summary of the measurement methods of digital economy, this paper uses the measurement method of Wang Jun et al. (2021) for reference to build the evaluation index system of digital economy development, which includes three second-level indicators of digital infrastructure, digital industrialization and industrial digitalization, as shown in Table 1.

Measure of the mediating variable
    As farmer entrepreneurship a binary dummy variable, most studies use the form of questionnaire to investigate whether farmers start businesses or not. Therefore, starting from the authenticity and availability of data, the agricultural household registration in each province is selected, and then determine it according to whether the family does non-agricultural work for themselves or their own family in CFPS. If you are working for yourself or your own family, it is defined as entrepreneurship, and the value is 1, otherwise is 0.

Measure of control variables

In terms of the selection of control variables, this paper selected some of the interviewees' personal characteristic variables and family characteristic variables by referring to the current research conclusions. The variables are defined in Table 2.

Table 1. Digital economy development evaluation index system

First level indicators	Second level indicator	Third level indicator
Digital Economy Development Index	Digital Infrastructure Sub-index	Mobile phone base station
		Number of domain name
		Number of broadband Internet access ports
		Number of IPv4 address
	Digital Industrialization sub-index	Total volume of telecommunications services
		Software product revenue scale
		Information technology services revenue
		Number of high-tech enterprises
		Main business income of high-tech enterprises
		Total profits of high-tech enterprises
	Industrial Digitization sub-index	Computer use per 100 people
		Proportion of enterprises engaged in e-commerce transactions
		E-commerce sales
		Information transmission, software and information technology service workers
		Digital Financial Inclusion Index

Table 2. Variable definitions

Variable name	Variable symbol	Variable definitions
Farmer income	lnincome	The logarithm of per capita net household income
Digital economy	dei	Comprehensive development index of digital economy
Ffarmer entrepreneurship	fe	Being engaged in entrepreneurial activity is given a value of 1, otherwise 0
Gender	gender	It's 1 for males and 0 for females
Age	age	One full year of life
Marry	marry	It's 1 in marriage and 0 in non-marriage
Health protection situation	medical	With health insurance is 1, without health insurance is 0
Schooling	edu	Years of education: no schooling is 0; 6 in primary schools; junior high school was 9; 12 for high school/secondary school; junior college was 15; achelor degree of 16; master's degree 19; Dr is 22
Job satisfaction	job_pleased	Overall job satisfaction: very dissatisfied 1; 2 is not very satisfied; usually is 3; relatively satisfied is 4; very satisfied with 5
Family scale	fsize	Number of family members
Expenditure on courtesies	lnsoc_cap	The logarithm of expenditure on courtesies

3.3   Empirical model

In order to empirically analyze the impact of digital economy on farmers' income increase, the following model is first set for the direct transmission mechanism:

$$lnincome_{it} = \alpha_0 + \alpha_1 dei_{it} + \alpha_2 X_{it} + \alpha_3 V_{it} + \lambda_t + \mu_i + \varepsilon_{it} \tag{1}$$

In Equation (1), X represents the variable related to family characteristics, V is the variable related to individual characteristics, μ_i is the year effect, λ_t represents the individual effect, and ε_{it} is the residual term.

To study the possible indirect action mechanism of digital economy on farmers' income increase, and test whether the level of farmers' entrepreneurship is the intermediary variable between the two, this paper constructs the following mediation effect model:

$$fe_{it} = \beta_0 + \beta_1 dei_{it} + \beta_2 Z_{it} + \lambda_t + \mu_i + \varepsilon_{it} \tag{2}$$

$$lnincome_{it} = \gamma_0 + \gamma_1 dei_{it} + \gamma_2 fe_{it} + \gamma_3 Z_{it} + \lambda_t + \mu_i + \varepsilon_{it} \tag{3}$$

4   Empirical result

4.1   Descriptive statistics

Table 3 reports the descriptive statistical results of the main variables in this paper. It can be seen that the mean value of lnincome of farmers is 9.289, the minimum value is -0.182, and the maximum value is 14.1, indicating that there are great differences in farmer income among the research samples. The mean value of digital economy (dei) is 0.153, the minimum value is 0.01, and the maximum value is 0.841, indicating that the digital economy varies greatly among all samples, which also provides conditions for the research of this paper.

Table 3. Descriptive statistics

variable	N	mean	sd	min	max
income	25092	9.289	0.991	-0.182	14.100
dei	25092	0.153	0.165	0.010	0.841
fe	25092	0.088	0.284	0	1
marry	25092	0.897	0.303	0	1
gender	25092	0.516	0.500	0	1
age	25092	40.920	11.300	16	60
edu	25092	8.228	5.017	0	22
job pleased	25092	3.494	0.927	1	5
medical	25092	0.932	0.251	0	1
fsize	25092	4.687	1.989	1	19
lnsoc cap	25092	7.796	1.067	0	11.850

4.2 Basic regression analysis

Table 4 reports the baseline regression results. Column (1) only controls the comprehensive development index of digital economy, while from column (2) to column (3), individual characteristics and family characteristics are gradually introduced. The results show that with the introduction of different types of variables, the model fitting value presents an upward trend. In the three models, the comprehensive development index of digital economy shows a significant positive correlation with farmers' income, indicating that the development of digital economy is conducive to improving farmers' income. When the comprehensive development index of digital economy increases by 1 standard unit, farmers' income will change by 35.4% to 48.3%, reflecting the promoting effect of the development of digital economy on farmers' income. Hypothesis 1 of this paper is verified.

Table 4. Basic regression analysis

	(1) income	(2) income	(3) income
dei	0.483***	0.474***	0.354**
	(0.180)	(0.180)	(0.178)
age		0.034*	0.030
		(0.020)	(0.020)
age2		-0.001***	-0.001***
		(0.000)	(0.000)
gender		0.024	0.051
		(0.285)	(0.281)
edu		0.008	0.005
		(0.005)	(0.005)
marry		-0.217***	-0.183***
		(0.060)	(0.060)
medical		0.027	0.026
		(0.031)	(0.031)
job_pleased		0.024***	0.020**
		(0.009)	(0.008)
fsize			-0.080***
			(0.006)
lnsoc_cap			0.102***
			(0.009)
_cons	8.856***	8.539***	8.414***
	(0.022)	(0.674)	(0.672)
Individual	YES	YES	YES
Year	YES	YES	YES
N	25092	25092	25092
R^2	0.159	0.162	0.181

Note: standard error in parentheses; $^* p < 0.1$, $^{**} p < 0.05$, $^{***} p < 0.01$.

It can also be seen from Table 4 that the control variables, job satisfaction and gift expenditure, have a significant positive impact on the increase of farmers' income. This means that along with rising job satisfaction and spending on family favors, farmers' incomes are also rising. Age, marital status and family size have a significant negative impact on farmers' income. This means that a new generation of young farmers has seen their incomes rise higher than those of older farmers; The income level of unmarried farmers is higher. In addition, farmers with smaller families saw their incomes rise more than those with larger families.

4.3   Mechanism test and heterogeneity analysis

Mechanism test

In order to further explore the influence mechanism of digital economy on the improvement effect of farmers' income, this paper introduces farmers' entrepreneurship as the intermediate transmission mechanism variable affecting the digital economy and the improvement of farmers' income. The results show that the mechanism of digital economy development-farmer entrepreneurship- farmer income increase did not exist in 2014. While the table 5 shows that farmers' entrepreneurship is the development of the digital economy to increase farmers' income mechanism from 2016 to 2020, hypothesis 2 of this paper is verified.

Table 5. Mechanism of inspection-2016, 2018 and 2020

	(1) income	(2) fe	(3) income
dei	0.591***	1.859***	0.584***
	(0.037)	(0.301)	(0.037)
fe			0.081***
			(0.021)
_cons	8.065***	-14.451***	8.085***
	(0.106)	(1.079)	(0.106)
Control variables	YES	YES	YES
Individual and Year	YES	YES	YES
N	17890	17890	17890
R^2	0.171		0.170

Note: standard error in parentheses; $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Heterogeneity analysis

This paper further explores the heterogeneity of the impact of digital economy development on farmers' income from two aspects: regional and age, and the heterogeneity test also takes into account control variables such as family characteristics and individual characteristics. The results are shown in Table 6.

According to the regression results, in the eastern and central regions, the digital economy has a promoting effect on the improvement of farmers' income, while in the western region it has a inhibiting effect, indicating that the digital economy has different effects on the improvement of farmers' income in different regions. The reason is that compared with the central and eastern regions, the western region has a slower economic development, and farmers live on traditional agriculture. With the development of digital economy, the traditional agriculture in rural areas has been impacted, thus affecting the improvement of farmers' income.

The samples are divided into young and middle-aged farmers according to age, and the regression results in Table 6 show that the digital economy has a significant positive impact on the income increase of both young and middle-aged farmers, but the impact on young farmers is greater than that on middle-aged farmers. Maybe the reason is that in the modern information society, the application of internet and other digital technologies is more widely used in the youth group.

Table 6. Heterogeneity analysis

	Eastern Region	Middle Region	Western region	Youth	The middle
	income	income	income	income	income
dei	0.579***	1.137***	-0.578***	0.719***	0.635***
	(0.053)	(0.262)	(0.170)	(0.053)	(0.055)
_cons	7.699***	7.763***	7.954***	7.066***	2.972***
	(0.170)	(0.179)	(0.161)	(0.227)	(0.603)
Control variables	YES	YES	YES	YES	YES
Individual and year	YES	YES	YES	YES	YES
N	8377	6990	9725	11052	14040

Note: standard error in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.4   Robustness test

In this paper, the robustness test is carried out by replacing the measure of explanatory variables and removing possible outliers. The results show that the conclusions of this paper are relatively robust.

5   Conclusions

Based on the data of China Family Panel Studies and the digital economy development index of each province, this paper studies the impact of digital economy development on farmers' income, and mainly draws the following conclusions: firstly, digital economy can significantly promote the increase of rural residents' income and become an

important driving force for farmers' income increase. Through the test of changing the measurement method of explanatory variables and eliminating possible outliers, the results are still robust. Secondly, the level of farmers' entrepreneurship, as the intermediary variable of digital economy affecting farmers' income increase, significantly improved the level of farmers' entrepreneurship during the sample period, and indirectly promoted the increase of farmers' income from 2016 to 2020, with significant intermediary effect. Thirdly, The effect of digital economy on farmers' income increase has regional and age heterogeneity.

References

1. Han, X.F., Song, W.F., Li, B. X.(2019) Can Internet become a new driving force for improving regional innovation efficiency in China? China Industrial Economics, 07: 119-136. doi: 10.19581/j.cnki.ciejournal.2019.07.007.
2. Wang, J., Zhu, J., Luo, Q.(2021) The development level and evolution measure of China's digital economy. Journal of Quantitative and Technical Economics, 07: 26-42. doi: 10.13653/j.cnki.jqte.2021.07.002.
3. Jeannendy, S G, Kpodar, K.(2011) Financial development and poverty reduction: can there be a benefit without a cost?The Journal of Development Studies,47:143-163. https: //doi.org/10.1080/00220388.2010.506918.
4. Philip, L., Cottrill, C., Farrington J, et al. (2017)The digital divide: Patterns, policy and scenarios for connecting the 'final few' in rural communities across Great Britain. Journal of Rural Studies,54: 386-398. https://doi.org/10.1016/j.jrurstud.2016.12.002.
5. He, Y.Q., Xiong, Z.Y., Zhang, K., et al (2023). Digital economy development, non-farm employment and farmers' income increase. Statistics and Decision 16:111-115. doi: 10. 13546/j.cnki.tjyjc.2023.16.021.
6. He, Y.P., Xu, K.N. (2019) The impact of Internet on Urban-Rural income gap: A case study based on China. Economic Longitude, 02: 25-32. doi: 10.15931/j.cnki.1006-1096. 20190115.010.
7. Li, X.Z., Li, J. Y. (2022) Study on the impact of digital economy development on urban-rural income gap. Journal of AgroTechnical Economics, 02:77-93. doi: 10. 13246/ j. cnki. jae.20210916.005.
8. Chen, H.Q., Chen, G.S., Wei, X.B., et al.(2021) The Effect of Digital financial Inclusion on income and poverty Reduction: An Empirical analysis based on inter-provincial panel data. Economic Geography, 03: 184-191. doi: 10.15957/j.cnki.jjdl.2021.03.019.
9. Wang, Y., Liu, L. (2022) How Migrant Workers return to their hometowns to start their own Businesses to promote common prosperity of farmers and rural areas. China Rural Economy, 9: 44-62. http://kns.cnki.net/kcms/detail/11.1262.F.20221011.1308.006.html.

310   H. Chen and C. Yang