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Digital Literacy, Farmers' Income Increase and Rural Internal Income Gap

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Abstract: The digital economy has promoted the income growth of rural residents in China, but it has also widened the income gap within rural areas. The excessive income gap will lead to the uneven distribution of social resources and the decline of efficiency, thus threatening the sustainable development of the rural economy. This study utilizes the 'Circumstances-Efforts' analytical framework, the skill-biased technology change theory, and data from the China Family Panel Studies (CFPS) in 2018 to examine the impact of digital literacy on income growth among rural residents and the resulting income gap within rural areas. The findings indicate that digital literacy positively contributes to the income growth of rural residents. Moreover, the mechanism analysis reveals that improved access to digital devices and more effective information play a significant role in enhancing the income of rural residents. Furthermore, the analysis of income structures demonstrates that digital literacy has a greater impact on increasing wage income and agricultural income for both high-income and low-income rural residents. However, it is important to note that digital literacy also contributes to the widening income gap within rural areas, particularly impacting high-income rural residents.

Keywords: digital literacy; increasing farmers' income; income gap

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1. Introduction

The issue of income inequality is an economic issue of general concern to all countries, not only as a matter of "equity" but also as a matter of "efficiency". Excessive income inequality not only results in an uneven distribution of social resources, hindering the pursuit of shared prosperity, but also leads to a growing wealth divide. This wealth divide can reduce individual motivation and work incentives, thereby impacting economic growth and overall efficiency. Income disparity encompasses not only the gap between urban and rural areas but also inequality within these regions among residents. China has implemented the 'rural revitalization strategy' in recent years, leading to a notable increase in rural residents' incomes. However, concurrently, the income gap among rural residents in China has been expanding continuously (refer to Figure 1) [1]. In 2021, in the quintile grouping of rural residents' per capita disposable income, the income gap between the 20% of rural households with the highest income and the 20% of rural households with the lowest income reached 8.87 times, with a significant intra-rural income gap. Comparing the intra-income gap between urban and rural residents, income inequality is even more pronounced in rural areas, with the intra-rural income gap consistently higher than in urban areas [2]. An excessive income gap among rural residents not only undermines social stability but also hinders the sustainable development of the rural economy. Conversely, a moderate income gap can foster economic growth and reduce overall income inequality [3].

The core of controlling income inequality lies in promoting income growth for rural residents. Technological advancements in agriculture play a crucial role in fostering rural economic growth and increasing the income of rural residents [4,5]. The integration of digital technology in agriculture is particularly recognized as a significant catalyst for

transformative changes in agricultural production. China has made significant strides in digital rural development, harnessing internet technologies to introduce new economic models in rural areas, such as platform economies and flow economies. These innovations have spurred economic growth and ultimately contributed to income growth for rural residents [6,7]. However, though the adoption of digital technologies in rural China has resulted in income growth, this growth has developed alongside an undesirable widening of income disparities among rural residents [6,8–12]. While digital technology provides equal opportunities for all rural residents, disparities in digital literacy among farmers leads to an uneven distribution of the digital dividend [13].

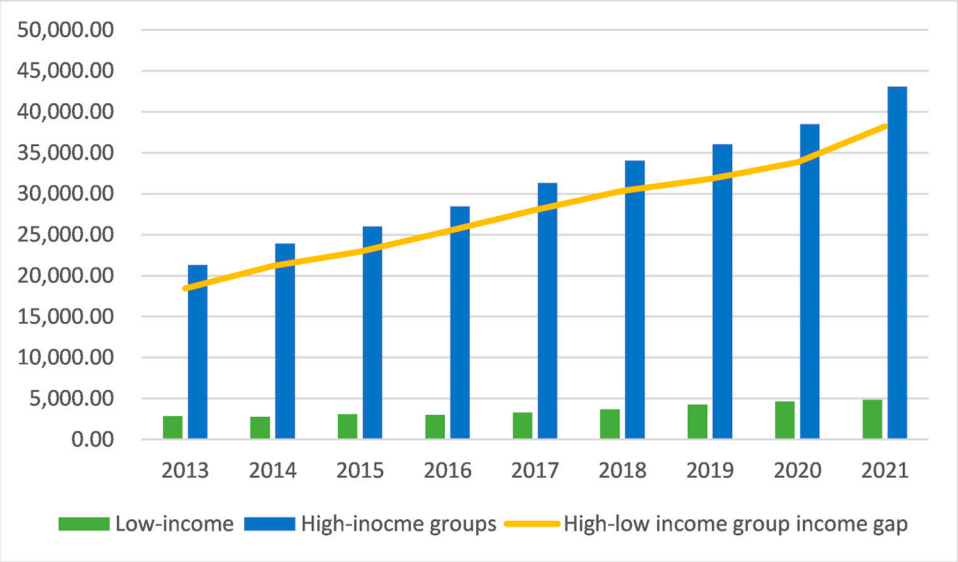

Figure 1. Income changes and income gap trends of rural low-income groups and high-income groups in China. (Unit: Yuan). Data source: China Statistical Yearbook 2014–2022.

The sharing of the digital dividend by rural residents depends on two factors: the accessibility of digital facilities and the ability to use digital technologies [8,14]. China's achievement of providing 100% Internet broadband access in administrative villages by the end of 2021, along with over 99% coverage of fiber optics and 4G networks, ensures widespread Internet connectivity for farmers. However, significant disparities persist in the proficiency of rural residents in utilizing digital technologies. According to a rural digital literacy survey report published by the Chinese Academy of Social Sciences, rural residents have an average digital literacy score of only 35.1 (on a percentage scale). This figure indicates a significant 37.7% lower digital literacy when compared to urban residents, resulting in an absolute difference of 21.2 points (on a percentage scale). This low level of digital literacy not only impacts farmers' daily activities, such as online shopping, ticketing, and news access, but also hinders their ability to leverage income-generating opportunities provided by digital technology, including rural e-commerce and live-streaming e-commerce, thereby affecting their overall income potential.

Studies have primarily investigated the impact of the digital economy on rural residents' income. One approach is based on macro indicators and aims to construct a digital economy evaluation system, assessing its potential to enhance farmers' income levels and reduce the urban-rural income gap [15–18]. The second approach focuses on the micro-level analysis, specifically examining the impact of e-commerce as a manifestation of the digital economy on individual farmers' income. These studies argue that e-commerce plays a crucial role in fostering the income of rural residents [8,19,20]. Third, studies explore the relationship between the usage of digital technologies, such as the Internet or mobile phones, and their impact on individual farmers' income. These studies argue that the adoption of digital technologies contributes to the improvement of rural residents' income

levels [6,10,21–23]. Finally, studies examine the impact of digital infrastructure accessibility, including the construction of digital facilities, on farmers' income and income gaps. These studies argue that the development of digital infrastructure has led to increased farmers' income and a reduction in the urban-rural income gap [24–26].

The aforementioned studies provide an important foundation for the research in this paper, but there is room for expansion. First, there is a need to place greater emphasis on examining the impact of digital literacy on the income of rural residents. Given the assumption that the 'access gap' of the digital divide in rural China has significantly diminished [27], the importance of digital literacy among rural residents has become paramount in income generation, i.e., whether rural residents have the ability to grasp the income generation opportunities brought about by digitalization. Hence, it is crucial to enhance research efforts that examine the income-generating impact of digital literacy. Further investigation is required to clarify the influence of digital literacy on both agricultural income and non-agricultural wage income within the income structure of rural residents. Existing studies have found the effect of digital literacy on the property income of rural residents [28,29]. However, digital literacy, which is essentially the ability to face the use of digital technology, will not only affect rural residents' property income, but also other incomes, such as wage income, where improved digital literacy will enable more access to labor information, thus improving their chances of engaging in labor jobs, which in turn will help to improve their wage income. It will also have an impact on agricultural business income, where the improvement of digital literacy will reduce the cost of rural residents' access to information, which will improve their bargaining power and agricultural sales market, and thus improve their agricultural business income. Thus, research on the impact of digital literacy on various income structures among rural residents is necessary. Third, the impact of digital literacy differences on the income gap within rural residents needs to be further studied. There are several factors that affect the income gap of rural residents, but in the context of the digital economy, the application of digital technology has brought income opportunities for farmers [23], so rural residents with high digital literacy have more income increases. On the one hand, there is the phenomenon of "digital poverty" among rural residents, which leads to less or more difficult access to income. On the other hand, there is also the phenomenon of "digital poverty" among rural residents, which leads to less or more difficult access to digital dividends [30], resulting in a widening income gap. Consequently, conducting further research to investigate the impact of digital literacy on the income gap among rural residents is essential.

This paper empirically examines the relationship between digital literacy, income growth of rural residents, and intra-rural income disparity using data from the China Family Panel Studies (CFPS) 2018. Compared with the existing literature, the possible innovations of this paper are as follows. First, by employing the 'Circumstances-Efforts' analysis framework, this paper examines the impact mechanism of digital literacy on the income of rural residents, contributing to a better understanding of how digital literacy influences income growth. Second, this study dissects the income structure of rural residents and investigates the influence of digital literacy on various components, including agricultural income and non-agricultural wage income. By doing so, it unveils the microscopic mechanisms through which digital literacy affects income growth among rural residents. Third, this paper examines the impact of digital literacy on the internal income disparity among rural residents, thus contributing to the enrichment of research in the field of rural income.

2. Theoretical Analysis and Research Hypothesis

The 'Circumstances-Efforts' framework of analysis developed by Roemer (1993) identifies two primary factors underlying income inequality: 'Circumstances' and 'Efforts' [31]. 'Circumstances' pertains to factors that are beyond individuals' control, such as gender and race, while 'Efforts' encompasses variables that individuals can influence, including education level and working hours, etc. Individual effort plays a crucial role in ameliorating

opportunity inequality and boosting individual income [32]. Furthermore, according to the new human capital theory, the development of capabilities is a significant pathway to income enhancement [33]. Digital literacy is a vital skill for navigating the digital age, encompassing abilities required to effectively live, learn, and work in a digitally-driven society [34] It arises from the context of the Internet's widespread prevalence and immense value [35]. Enhancing farmers' digital literacy not only enables them to utilize digital information and technological tools to address challenges in both their professional and personal lives, but it also boosts their capacity to embrace digital trends [36]. As a result, farmers can more easily seize the opportunities presented by the digital era, ultimately leading to higher income attainment.

The impact of digital literacy on the income of rural residents can be divided into "Technological Opportunity Effect" and "Information Opportunity Effect" [6]. The "technology opportunity effect" refers to the opportunity to increase income from the use of digital devices, which often brings new changes from traditional production methods and can promote labor productivity, changes in work practices, and even new products or services, thus increasing income. Farmers with high digital literacy have a lower threshold for learning to use digital devices than those with low digital literacy and are more likely to be the first to use digital devices and realize increased income. Several studies have been conducted to test the impact of digital devices on income growth of rural residents. For example, Krueger's (1993) study showed that computer use can generate a 10–15% rate of return for users [37]; Yuyu Chen and Yuli Wu's (2008) study found a 20% rate of return for personal computer use in China [38]; Gao et al. (2018) examined the impact of computer penetration on rural residents' income and found that, over time, rural computer penetration has a tendency to increase the income of rural residents [23]. In addition to computers, other digital technologies, such as the Internet and cell phones, have similar effects. It was found that the use of digital technologies such as cell phone signals, 2G and 3G mobile networks [10], and the Internet [6,21,22,39] contributed to the increase in total farm household income. Therefore, rural residents can increase their income by increasing their access to digital devices.

The "information opportunity effect" refers to the income enhancement opportunities brought by information dissemination. Digital technology brings rapid information transmission and a huge increase in the volume of information, which can bring users more knowledge, easier information communication, and new economic opportunities, and thus income enhancement. On the one hand, digitally literate farmers can make better use of digital technology to alleviate information constraints, which, according to the information asymmetry theory, can lead to price dispersion and disparity of agricultural products, thus affecting farmers' income [27]. On the other hand, digitally literate farmers can also use digital technology to actively search for information to gain knowledge or opportunities and increase their chances of income enhancement. According to search theory, farmers are limited by the cost of information search, and when the cost of information search is low, farmers will conduct more appropriate information searches to achieve optimal resource allocation and income enhancement. Digital technology can alleviate farmers' information constraints and reduce the cost of information search [40,41], thus helping rural residents to increase their income.

In the context of the digital economy, although digital technology brings equal access, due to the differences in individual digital literacy and thus the use of digital technology, rural residents with high digital literacy are able to use digital technology earlier and faster and form a certain first-mover advantage. In addition, according to the theory of skill-biased technology change, technological progress is more favorable to high-skilled workers, i.e., digital technology progress will be more favorable to rural residents with high digital literacy, who will benefit more from digital technology, thus increasing the income gap with rural residents with low digital literacy.

Based on the above theoretical analysis, this paper proposes the following hypotheses:

Hypothesis 1. *Digital literacy can significantly increase the income of rural households.*

Hypothesis 2. *Digital literacy increases household income by increasing access to digital devices.*

Hypothesis 3. *Digital literacy increases household income by increasing access to information.*

Hypothesis 4. *Differences in digital literacy increase intra-rural income disparities.*

3. Materials and Methods

3.1. Model Setting

In order to estimate the impact of farmers' digital literacy on farmers' income, given that the dependent variable is income, which is a continuous variable, referring to the existing literature [18,28], the least square method (OLS) is used as the benchmark regression model.

$$\ln(income_i) = \alpha + \beta Dliteracy_i + \lambda X_i + \varepsilon_i \quad (1)$$

where i denotes different farm households; $income_i$ denotes the total income of farm household i. Here, the log form of total income is used in the estimation; $Dliteracy_i$ denotes the numerical literacy of farm household i, which is the explanatory variable of interest in this paper; X_i denotes the control variables, including individual characteristics, household characteristics, and regional characteristics, etc.; α is the constant term; ε_i is the random disturbance term.

3.2. Data Sources and Variable Selection

3.2.1. Source of Data

The data used in this paper are from the China Family Panel Study (CFPS) 2018 survey data. The database includes individual, household, and community level data covering household economic activities, demographics, educational outcomes, and health. The CFPS uses a sample survey covering more than 3000 villages and dwellings in 25 provinces/municipalities/autonomous regions across the country, including visits to 15,000 households to collect about 44,000 individual questionnaires; the target respondents include all members of the sample households. The research method was a data collection method based on door-to-door interviews with households, supplemented by telephone interviews, with the number of questionnaires completed by telephone interviews accounting for 22% of all questionnaires. Since the subject of this research is farmers, it is necessary to exclude the sample of farmers. When processing the data, the hukou indicator, which is a kind of household registration system that can distinguish between urban residents and farmers, is used to screen out whether it is a rural resident or not, and the non-agricultural hukou and missing data of key variables in the sample are eliminated. In order to avoid the influence of outliers, the sample members who are younger than 18 and older than 85 are excluded. In total, 5113 sample data are obtained.

3.2.2. Variable Selection

Explanatory variable: per capita net income. The main research objective of this paper is to examine the effect of farmers' digital literacy on farmers' income growth. Since farmers' digital literacy is an individual variable, household income per capita is selected and measured as the logarithm.

Core explanatory variable: digital literacy. Digital literacy itself is a reflection of ability. Here we mainly refer to the measurement method of Wang J et al. (2022) [13], which measures farmers' digital literacy with the help of questions related to Internet use in the questionnaire, and the specific questions include "frequency of using the Internet for learning", "frequency of using the Internet for work", etc. The specific questions include "frequency of using the Internet for learning", "frequency of using the Internet for work", "frequency of using the Internet for socializing", "frequency of using the Internet for entertainment", and "frequency of using the Internet for business activities". The

KMO value of the five questions is 0.833, which is suitable for factor analysis to reduce dimensionality and extract a common factor.

Mechanism variables. First, computer use. Digital literacy affects income mainly through the technology opportunity effect and the information opportunity effect, and the technology opportunity effect is mainly measured by whether to use the computer to access the Internet. At present, the main digital device used by farmers is the mobile phone. The emergence of mobile phones provides a convenient digital platform for farmers, but the requirement of mobile phone use is much lower than the digital literacy requirement of computer, which does not reflect the difference between farmers' digital literacy well. Specifically, the question "whether to use computer to access the Internet" in the CFPS questionnaire was used to measure the influence of farmers' digital literacy on the use of digital devices. The use of a computer to access the Internet is recorded as 1, otherwise it is 0. Second, access to information. Access to information was measured by the question "How important is the Internet information channel to you?" in the CFPS questionnaire, with a five-point scale from very unimportant to very important, with values from 1 to 5, with higher values indicating more valuable access to information.

Control variables. Based on existing literature studies [6,28,42], three aspects of individual farmer characteristics, household characteristics, and regional characteristics were selected. Individual farmer characteristics include gender, age, age squared, risk preference, health status, years of education, and marital status; household characteristics include household size, social network, and household net worth; regional characteristics are controlled by whether or not they are eastern regions, in order to reflect the differences in economic levels between regions.

Table 1 shows the definition of key variables and descriptive statistics.

Table 1. Definition of key variables and descriptive statistics.

Classification	Variable Name	Definition	Mean	SD
Dependent variables	Net income per capita	Annual net income divided by household size (taken as logarithm)	9.32	0.96
	Total net income	Net annual household income (taken as logarithm)	10.56	1.07
	Wage income per capita	Annual household wage income divided by the number of persons in the household (Add one to take the logarithm)	6.67	4.07
	Net agricultural income per capita	Annual household agricultural income divided by the number of persons in the household (Add one to take the logarithm)	3.66	3.80
Core explanatory variables	Digital literacy	Final values obtained by factor analysis	0.008	1.007
Control variables	Gender	Female = 0; Male = 1	0.56	0.50
	Age	Age of respondent (years)	53.12	12.98
	Age squared	Age squared	2990.38	1364.61
	Risk preference		2.03	1.68
	Health status	very healthy = 1; very healthy = 2; relatively healthy = 3; Fair = 4; Unhealthy = 5	5.34	1.35
	Years of education	Number of years of education	5.80	4.40
	marital status	Married = 1; Other = 0	0.87	0.34
	Household size	1–21	3.90	1.92
	Social networks	Annual Gift Expenses	7.03	2.55
	Household net worth	Household net assets	447,802.49	1,257,232.78
	Eastern region	Eastern = 1; Other = 0	0.40	0.49

4. Estimation Results and Analysis

4.1. The Benchmark Model Regression of Digital Literacy AffectingFarmers'Income

The basic regression results of the effect of digital literacy on rural residents' income are shown in Table 2. First, the digital literacy variable alone is entered into the model, and the results show that digital literacy significantly increases the income of rural residents. Then, on this basis, three control variables at the level of individual characteristics, household

characteristics and regional characteristics of rural residents are separately added to the regression model; model (4) is the estimated result after adding all the control variables. The results show that the digital literacy variable is significant and has a positive coefficient, indicating that digital literacy helps to improve the income of rural residents. Thus, Hypothesis 1 is confirmed.

Table 2. The effect of digital literacy on farm household income.

Variables	OLS (1)	OLS (2)	OLS (3)	OLS (4)
Digital literacy	0.318 *** (0.013)	0.230 *** (0.016)	0.182 *** (0.016)	0.180 *** (0.015)
Gender		−0.067 *** (0.025)	−0.034 (0.024)	−0.022 (0.024)
Age		0.055 *** (0.007)	0.038 *** (0.007)	0.037 *** (0.007)
Age squared		−0.001 *** (0.000)	−0.000 *** (0.000)	−0.000 *** (0.000)
Risk appetite		−0.004 (0.007)	−0.007 (0.007)	−0.005 (0.007)
Health status		0.057 *** (0.009)	0.051 *** (0.009)	0.047 *** (0.009)
Years of education		0.038 *** (0.003)	0.034 *** (0.003)	0.031 *** (0.003)
Marital status		−0.011 (0.038)	0.013 (0.037)	0.003 (0.037)
Household size			−0.082 *** (0.006)	−0.077 *** (0.006)
Social networks			0.075 *** (0.005)	0.078 *** (0.005)
Household net worth			0.000 *** (0.000)	0.000 *** (0.000)
Eastern Region				0.158 *** (0.024)
Constant	9.315 *** (0.013)	7.595 *** (0.189)	7.832 *** (0.181)	7.796 *** (0.180)
Observations	5113	5113	5113	5113
R-squared	0.112	0.168	0.246	0.253

Notes: *** represent significance at the 1% statistical levels, respectively; robust standard errors are in brackets.

4.2. Endogenous Treatment andRobustness Analysis

4.2.1. Endogenous Treatment

The estimation results of the baseline model suggest that digital literacy can increase the income level of rural residents, but the income of rural residents may affect the level of digital literacy; for example, higher income may increase the digital literacy of users by purchasing digital devices such as mobile phones or computers earlier, so there may be an endogeneity problem caused by reverse causality. Based on the study by Depeng Shan et al. (2022) [28], a two-stage regression was conducted using "Internet usage rate in the same province and city other than the farmers themselves" as the instrumental variable. The F-value of the first-stage regression is much higher than 10, indicating that there is no weak instrumental variable; the results of the second-stage regression show that the coefficient of farmers' digital literacy is significantly positive at the 1% level, indicating that digital literacy has an income-increasing effect on rural residents' income (see Table 3). When compared with the baseline regression results, it is found that the effect of farmers' digital literacy on rural residents' income becomes larger after the introduction of instrumental variables, suggesting that ignoring the endogeneity problem leads to underestimation of the income-increasing effect of farmers' digital literacy.

Table 3. Results of endogenous analysis.

Variables	Second-Stage Regression	First-Stage Regression
Digital literacy	0.763 *** (0.135)	
IV		1.638 *** (0.169)
Control variables	Yes	Yes
Constant	5.529 *** (0.582)	3.650 *** (0.200)
Observations	5111	5111

Notes: *** represent significance at the 1% statistical levels, respectively; robust standard errors are in brackets.

4.2.2. Robustness Test

In order to ensure the robustness of the baseline regression results, the robustness tests were conducted in the following three ways: first, substituting the explanatory variables, substituting the explanatory variables with net household income, and inserting them into the baseline model for estimation; second, substituting the explanatory variables for measurement, referring to the method of DePeng Shan et al. (2022) [28], using the proportion of different subscores of farmers' digital literacy in the sample to the total score of this item in the province, and then adding each subscore to the total score of this item to obtain the regression coefficients; third, excluding the effect of extreme values, the regression coefficients of digital literacy are still significantly positive after the upper and lower 1% tailing process.

From the above results, it can be seen that the regression coefficients of digital literacy are significantly positive regardless of replacing the explanatory variables, adjusting the measurement of the explanatory variables, or excluding the extreme values. This indicates that the basic regression results have some robustness (see Table 4).

Table 4. Robustness test estimation results.

Variables	Household Net Income	Net Income per Capita	Net Income per Capita
Digital literacy	0.183 *** (0.016)		
Digital literacy (1)		0.584 ** (0.273)	
Digital literacy (2)			0.181 *** (0.016)
Control variables	Yes	Yes	Yes
Constant	7.777 *** (0.180)	8.400 *** (0.172)	7.798 *** (0.182)
Observations	5113	5113	5113
R-squared	0.386	0.236	0.253

Notes: ***, ** represent significance at the 1%, 5% statistical levels, respectively; robust standard errors are in brackets.

4.3. Mechanism Test and Expansion Analysis

4.3.1. Mechanism Test

According to the previous theoretical analysis, digital literacy increases the income of rural residents through the technological opportunity effect and the information opportunity effect, so this paper will empirically test these two mechanisms (Table 5).

Table 5. Mechanism Test.

Variables	Computer Use (Probit)	Accessing Information (Oprobit)
Digital literacy	0.763 *** (0.135)	0.553 *** (0.022)
Control variables	Yes	Yes
Observations	5113	5112

Notes: *** represent significance at the 1% statistical levels, respectively; robust standard errors are in brackets.

1. Technology Opportunity Effect

The effect of digital literacy on the use of digital devices by rural households is measured by the question "whether or not to use computer to access the Internet" in the CFPS questionnaire, using "computer use" as a proxy variable. Considering that "computer use" is a binary categorical variable, a binary probit regression analysis is conducted; the regression results show that the regression coefficient of digital literacy on computer use is positive and significant, indicating that the improvement of farmers' literacy contributes to the use of digital devices by rural residents. Thus, Hypothesis 2 is true.

2. Information Opportunity Effect

The results show that the regression coefficient of digital literacy on access to information is positive and significant. The results show that the regression coefficient of farmers' digital literacy on access to information is positive and significant, indicating that the improvement of farmers' literacy helps farmers to access information, and hypothesis 3 is valid.

4.3.2. The Influence of Digital Literacy on the Income Structure of Rural Residents

Considering the different characteristics of different income sources, the focus is on testing the effect of digital literacy of rural residents on agricultural income and non-farm wage income. Table 6 shows that digital literacy of rural residents has a significant positive effect on both non-farm wage income and agricultural income. It shows that digital literacy of rural residents helps to increase non-farm wage income and agricultural income, and that when rural residents are more literate, they can better use the information advantage brought by digital technology to obtain job opportunities, thus increasing their wage income. Meanwhile, for agricultural income, the possible explanation is that when rural residents are more literate, they can use the information opportunity effect to obtain more market information, reduce information asymmetry, and reduce transaction costs, and thus obtain an increase in agricultural income.

Table 6. The impact of digital literacy on the income structure of rural households.

Variables	Computer Use (Probit)	Accessing Information (Oprobit)
Digital literacy	0.763 *** (0.135)	0.553 *** (0.022)
Control variables	Yes	Yes
Constant	0.263	−3.526 ***
	(0.801)	(0.813)
Observations	5113	5070
R-squared	0.185	0.048

Notes: *** represent significance at the 1% statistical levels, respectively; robust standard errors are in brackets.

4.3.3. The Influence of Digital Literacy on the Internal Income Gap of Rural Residents

To test the effect of digital literacy on the intra-rural income gap of rural residents, with reference to Qiubo Zhu et al. [10], the per capita net income of the sample rural residents was divided into three equal groups, and the per capita net income, per capita wage income,

and per capita agricultural income were estimated for the high-, middle-, and low-income groups, respectively. If the marginal contribution of digital literacy to the low-income group is higher than that of the middle- and high-income groups, it indicates that digital literacy is conducive to reducing the intra-rural income gap, while the opposite indicates that it widens the intra-rural income gap. The estimated results are shown in Table 7. For both the low-income and high-income groups, digital literacy passed the significance test with positive coefficients; the marginal contribution is increasing, which means that the income-increasing effect of digital literacy on the high-income group is more pronounced and is likely to exacerbate the intra-rural income gap. Thus, hypothesis 4 is verified. There may be some "Matthew effect" of digital literacy, i.e., the income-raising effect is stronger for people with higher digital literacy. For wage income and agricultural income, although the income-raising effect of digital literacy is more pronounced in the high- and low-income groups for net income per capita, wage income per capita, and agricultural income per capita, the income-raising effect is greater for wage income.

Table 7. Impact of digital literacy on income disparity among rural residents.

Variables	Low Income	Middle Income	High Income
Net income per capita	381.219 *** (94.802)	72.090 (87.643)	3945.280 *** (1094.030)
Wage income per capita	576.735 *** (115.117)	−82.312 (175.027)	2063.350 *** (487.760)
Agricultural income per capita	165.473 *** (54.883)	104.248 (99.499)	585.460 * (324.612)

Notes: *** and * represent significance at the 1% and 10% statistical levels, respectively; robust standard errors are in brackets.

For the middle-income group, no matter the net income per capita, wage income per capita and agricultural income per capita pass the significance test. The possible reason for this is that the income increasing effect of digital literacy may have a certain threshold effect; when having lower digital literacy, it can promote income increase just by some simple information acquisition, such as labor information, price information, etc. To further realize the income-increasing effect of digital literacy for the middle-income group, according to the cross-tabulation analysis of income and digital literacy, it is found that the digital literacy of the middle and low-income groups is much lower than that of the high-income group, and that digital literacy may require higher digital literacy to produce further income-increasing effects on income. For the middle-income group, their digital literacy level still remains at achieving simple information processing, so that digital changes in digital literacy did not affect their income changes.

5. Discussion

The results of this study suggest that digital literacy can contribute to increasing the income of rural residents but does not contribute to reducing the income gap within rural areas. Compared with previous studies in the literature, the difference is that most of the existing literature focuses on the impact of the digital economy or digital technology itself, such as the impact of digital village construction, computer use, informatisation, e-commerce, etc. on income. This study, however, highlights another important factor that limits the role of digital technology: the digital literacy of rural residents. Digitalisation has changed the original mode of production in rural areas and provided new economic opportunities, but both the change in the mode of production and the exploitation of new economic opportunities require the mastery of new knowledge and skills in order to make them work. As such, examining the impact and mechanism of digital literacy on rural residents' income and the internal income gap in rural areas can help to better understand the role of digital literacy in the development of the digital economy in rural areas. This is conducive to the further development of the digital economy in rural areas. It

is worth noting that this role is not limited to rural China in this study but is also relevant to other countries. This is because the economic effects and mechanisms of digitalisation are not country-specific but require a certain level of digital literacy to ensure that digital technologies are as effective as they should be.

There are some limitations to our study. First, the dataset uses the CFPS; similar data exist in other countries, and the inclusion of other data would make this study more comprehensive. Second, the digital literacy measures in the current dataset are not yet perfect and do not fully reflect the level of digital literacy of rural residents; for example, the literacies proposed in the EU's DigComp2.2, such as digital content creation, security, etc., are not fully reflected in the CFPS due to the lack of digital literacy. This may lead to an underestimation of the income-generating effect of digital literacy, which will be improved in the future by designing appropriate research questionnaires and collecting micro-data.

6. Conclusions and Policy Implications

Based on the 2018 annual survey data of the CFPS, this paper investigates the impact of digital literacy on rural residents' income and intra-rural income disparity at the micro-farm household level. It is found that digital literacy has a significant positive effect on rural residents' net per capita income, wage income, and agricultural income; the results remain consistent after robustness tests including the instrumental variables approach. Among different income subgroups, digital literacy significantly contributes to the increase of rural residents' income for both high-income and low-income rural residents; the income increasing effect is better for the high-income group, while digital literacy exacerbates the intra-rural income gap.

With the progress of digitalization in China's rural areas, the Internet infrastructure in rural areas has achieved full coverage of administrative villages, realizing the accessibility of rural residents to digitalization. The ability to share the dividend of the digital economy is limited by the digital literacy level of rural residents. First, we should strengthen investment in education and training of digital literacy in rural areas to help rural residents improve their digital literacy level; second, based on the digital economy, the key to controlling the internal income gap in rural areas is to improve the digital literacy of low-income rural residents, which has a certain Matthew effect, and improving the digital literacy of low-income rural residents can enable them to enjoy the digital dividend more fully, which is conducive to narrowing the internal income gap in rural areas; third, we should continue to improve the digital literacy of rural residents. Finally, we should continue to improve the construction of digital infrastructure and information platforms, and increase the opportunities for rural residents to use digital devices by lowering the threshold for their use, so as to promote their income growth.

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