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Effect of Digital Economy Development on Rural-Urban Income Disparity: Evidence from China

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Abstract: Promoting income equality between urban and rural residents is one of the main goals of China's social progress and economic development. It is also a necessary means to achieve "common prosperity." Digital economy can effectively promote economic development, the adjustment of industry structure and industry upgrading, as well as increase the disposable income of urban and rural residents, which is theoretically beneficial to rural-urban income disparity. An empirical analysis is conducted based on the data of 30 provinces, municipalities, and autonomous regions in China from 2013 to 2020. The findings demonstrate that the growth of digital economy helps lessen rural-urban income disparity and has a significant effect in East China and North China.

Keywords: Digital economy; Income disparity; Regional heterogeneity; Rural-urban development divide

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1. Introduction

China's economy is in a period of transition, and digital economy has become a new source of growth for the nation. According to China's officials, digital economy has now made a considerable contribution to China's economic expansion, accounting for more than 60% of gross domestic product (GDP) with a scale exceeding RMB 45 trillion. However, the insufficient and imbalanced development between urban and rural areas is still prominent, with a significant gap in their development and income distribution. China's 14th Five-Year Plan and the Long-Range Objectives Through the Year 2035 clearly states that "the growth of per capita disposable income will keep pace with GDP growth, and there will be a significant improvement in the distribution structure." This is one of the main goals of China's social and economic development in this period. Therefore, promoting balanced economic growth between urban and rural regions and narrowing the rural-urban income gap have become pressing issues to be solved. It is of practical significance to study the role of digital economy, as the impetus for socio-economic development in the new era, in boosting income and reducing the rural-urban income disparity.

2. Literature review

There has been many academic research on how digital economy influences urban-rural income disparity. According to Chen Wen and Wu Ying, a "U-shaped" relation exists between digital economy development and income disparity, *i.e.*, rural-urban income disparity lessens at the early stage of development, but with further development, the inequality exacerbates, giving rise to the urban-rural digital divide phenomenon [1]. Wang Jun and Xiao Huatang argue that the effect of digital economy on rural-urban income disparity is regionally heterogeneous, with a lessening effect in the central and western regions, an increasing effect in

the eastern region, and no significant effect in the northeastern region [2]. According to Chen Xinxin and Duan Bo, digital economy significantly narrows the rural-urban income gap in East and Central China through agglomeration economies, but the western region fails to promote the agglomeration of production factors and cross-regional mobility, thereby widening the rural-urban gap [3]. Liu Jun argues that the advancement of digital economy makes a direct contribution to promoting income equality and facilitating labor mobility, which indirectly leads to better income distribution [4]. It can be seen that there are still disagreements among academics about the mechanism and effect of digital economy on rural-urban income disparity, thus requiring further analysis of regional heterogeneity.

In addition, evaluating the level of digital development in a region is also an issue that needs to be discussed and studied. Nowadays, most of the current indexes are constructed by research institutions and scholars themselves. For instance, China Digital Economy Development Index and The Peking University Digital Financial Inclusion Index of China were constructed by China Electronics Information Industry Development Institute and the Institute of Digital Finance of Peking University, respectively. These indexes are based on sufficient data and are credible, but on the one hand, it is difficult to obtain the data for these indexes, and they cannot be compared with each other. Hence, many scholars tend to construct their own indexes. For example, Bai Peiwen and Yu Li measured the level of digital economy development of each city from four aspects: digital products users, digital enterprises, digital platforms, and digital output [5]; Li Xiaozhong and Li Junyu constructed a different index, which includes digital foundation, application capability, industrial support, and development capability [6]. The significant variation in the constructed indexes used to measure the level of digital economy development affects the research conclusions to a certain extent.

The vast exploration of the connection between digital economy development and urban and rural citizens' income by scholars has an important reference value for this paper. This paper selects 12 measurement indicators, constructs a measurement index for determining the level of digital economy development, and studies the effect of digital economy on the income disparity between rural and urban citizens from theoretical and empirical perspectives.

3. Theoretical analysis

3.1. Digital economy can lessen rural-urban income disparity

The purpose of reducing the income gap is to increase the growth rate of rural residents' disposable income [7]. The influence mechanisms of digital economy on the rural residents' per capita disposable income can be summarized in several points.

Firstly, the main source of income for rural residents is agricultural production. Digital economy can improve the efficiency of agricultural production, thus driving their income growth. The construction of digital infrastructure is conducive to the efficient dissemination of information and reducing the time cost for rural residents to obtain information. On the one hand, rural residents can gain immediate access to practical information through the internet and learn about advanced agricultural production techniques, crop varieties, and cultivation methods, thus guiding their farming activity and improving productivity; on the other hand, rural residents can learn scientific and cultural knowledge through the internet at a lower cost and improve their education level, which in turn improves the quality of the rural workforce.

Secondly, the growth of digital economy has eliminated barriers to employment and boosted job opportunities, drawing talents to rural regions, boosting human capital, and improving rural revitalization. For example, internet enterprises have moved to the countryside, supported rural development, and participated in rural revitalization initiatives, thus creating more job prospects, significant income, and insurance, all of which are beneficial in attracting young people back to the village.

Thirdly, the growth of digital inclusive finance has had a knock-on effect on rural residents' income. Digital inclusive finance has increased the coverage of conventional financial goods and financial services, while lowering the cost of access for people in rural areas. Rural residents can, on the one hand, increase their property income level by investing and borrowing money, and on the other hand, purchase digital insurance services to safeguard themselves against unforeseen hazards, thus ensuring financial security. Digital inclusive finance benefits the agricultural sector as it increases efficiency and lowers financing costs. This helps the rural communities that rely on funding to grow their business and gain better economic benefits.

3.2. The effect of digital economy on rural-urban income disparity varies by area

The expansion of digital economy is mainly evaluated by the levels of digital economy infrastructure, digital industry development, and industrial integration [8]. Generally speaking, regions with rapid economic growth have relatively good infrastructure, high urbanization rate, and an industrial structure that is dominated by tertiary industries with high marginal returns. This gives them a certain geographical advantage in developing digital economy. In addition, most digital technology research institutes and leading digital industry enterprises are located in first-tier urban areas [9], rendering these regions a natural technological advantage in developing digital economy. An empirical analysis of regional heterogeneity is also presented in this paper.

4. Empirical analysis

4.1. Data sources

In our study, we selected data from 30 provinces in China from 2013 to 2020, We did not consider Tibet, Hong Kong, Macau, and Taiwan because the data for these areas were missing or found unsuitable for comparison with other areas. The data were mainly obtained from the National Bureau of Statistics of China and the statistical yearbooks of each province; the data related to digital finance were obtained from The Peking University Digital Financial Inclusion Index of China (2013–2020), which was compiled by the Institute of Digital Finance of Peking University.

4.2. Empirical model

According to the above theoretical analysis, we establish the following empirical model (1):

$$Theil_{i,t} = \alpha_0 + \alpha_1 Dig_{i,t} + \alpha_2 Z_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t} \tag{1}$$

$$Theil_{i,t} = \sum_{i=1}^{2} \left(\frac{y_{i,t}}{y_t} \right) \times \ln \left[\left(\frac{y_{i,t}}{y_t} \right) / \left(\frac{x_{i,t}}{x_t} \right) \right] \tag{2}$$

Theil is the predicted variable, which represents rural-urban income disparity. We used formula (2) to calculate the Theil index for different years in each region, where y_t is the per capita disposable income of all provincial residents in year t, x_t is the total resident population of a province at the end of the year in year t; when $i = 1$, the above variable indicates urban areas, but when $i = 2$, it indicates rural areas.

The explanatory variable is digital economy development index (Dig). For the selection of individual indicators, we have made extensive reference to various studies conducted by Grishchenko [9], Choi Changkyu and Yi Myung Hoon [10], Benlagha and Hemrit [11], Elena Toader *et al*. [12], Song Xiaoling [13], Zhang Xun *et al*. [14], Zhang Xun, Wan Guanghua, and Wu Haitao (2021) [15], Jing Wenjun and Sun Baowen [16], Xu Xianchun and Zhang Meihui [17], as well as Johannes Bauer [18]. We then decided on the following

12 indicators from three dimensions and constructed a digital economy indicator system, containing one primary indicator, three secondary indicators, and 12 specific indicators (as shown in **Table 1**). Based on this indicator system, the entropy evaluation method (EEM) was used to calculate our index.

Table 1. Digital economy development indicators

Primary indicator	Secondary indicators	Specific indicators
Level of digital economy development	Development of the infrastructure of digital economy	Cable density
		Mobile phone penetration rate
		Number of ports connected to internet broadband
		Number of users connected to internet broadband
	Level of development of the digital industry	Software business revenue
		Research and development (R&D) expenditure of industrial enterprises
		Revenue generation per new product for industrial enterprises
		Total telecommunications services per capita
	Level of digital transformation of the industry	The Peking University Digital Financial Inclusion Index of China
		Levels of online mobile payments
		Number of websites per 100 companies
		Average e-commerce sales of companies
		Average e-commerce purchases of companies

$Z_{i,t}$ is the group of control variables, which include economic development (Eco, the GDP per capita of each province in each year and logarithmically processed); industrial structure (Is, the ratio of the value of the tertiary sector to the value-added of the primary and secondary sectors); the educational level of the population (Edu, the average number of years of education of the population in the provincial regions); the structure of fiscal expenditure (Fes, the ratio of social security and employment expenditure, health expenditure, as well as agriculture, forestry and water affairs expenditure to the local general budget expenditure); and the age structure of the population (As, the ratio of the number of retired people and children to the number of the working-age population in each province).

μ_i denotes the regional fixed effect, δ_t denotes the time fixed effect, and $\varepsilon_{i,t}$ denotes the random error term.

The descriptive statistics for the explanatory variables, core explanatory variables, and control variables are shown in **Table 2**.

Table 2. Descriptive statistics

Name of variable	Sample size	Mean	Standard deviation	Minimum	Maximum
Theil (*Theil*)	240	0.132	0.061	0.016	0.290
Digital economy development level index (Dig)	240	0.101	0.090	0.007	0.496
Economic development (Eco)	240	10.868	0.412	9.997	12.009
Industrial structure (Is)	240	1.137	0.725	0.530	5.147
The educational level of the population (Edu)	240	9.530	1.175	7.474	13.438
Structure of fiscal expenditure (Fes)	240	0.330	0.056	0.180	0.489
Population age structure (As)	240	37.199	6.213	22.700	51.120

4.3. Empirical results

4.3.1. Results of the benchmark model

In **Table 3**, columns (1)–(4) are the regression results of the pooled ordinary least squares (OLS), fixed effects model, two-way fixed effects model, and random effects model, respectively, on which the Breusch-Pagan Lagrange multiplier (BP-LM) test and Hausman test were conducted. The results show that it is more reasonable to use the fixed effects model to regress the sample. In addition, a joint significance test of the time dummy variable was also conducted, in which the results show that the time effect needs to be controlled. Therefore model (3) is the optimal model.

Table 3. Results of benchmark model

	(1)	(2)	(3)	(4)
Dig	0.0676	-0.143***	-0.1479***	-0.115***
Eco	-0.0569**	0.0714***	0.0305	0.0545***
Edu	-0.0121***	-0.00150	-0.00513	-0.00132
Is	0.00884	-0.000699	-0.0101	-0.0119**
Fes	0.319**	0.0669**	-0.0202	0.150***
As	0.288**	0.0613**	0.0125	0.126***
cons	0.635**	-0.656***	-0.137	-0.516***
Regional fixed effect	No	Yes	Yes	No
Time fixed effect	No	No	Yes	No
Sample size	240	240	240	240

Note: *** $P < 0.01$, ** $P < 0.05$, and * $P < 0.10$

According to the findings of the two-way fixed effects model, the coefficient of the digital economy development index (Dig) is significantly negative at the 1% level, with an estimated value of -0.148, proving that there is an inverse relationship between digital economy development and rural-urban income disparity in China. This is in line with the theoretical analysis where the development of digital economy helps lessen income inequality.

4.3.2. Analysis of regional heterogeneity

Referring to the classification often used by scholars when collecting regional data [19][20], China's provinces can be divided into six regions: North China, East China, Northeast China, Central and South China, Southwest China, and Northwest China. Regression analysis was conducted using a two-way fixed effects model by region, and the results are shown in **Table 4**.

Table 4. Empirical analysis of regional heterogeneity

	(1) North China	(2) East China	(3) Northeast China	(4) Central and South China	(5) Southwest China	(6) Northwest China
Dig	-0.184***	-0.115***	-0.255	0.0528**	0.0298	-0.228
Eco	-0.00147	0.0139	0.0286	0.0834	0.238*	-0.0197
Edu	-0.0135**	-0.00357	0.00876	-0.000874	-0.0284**	0.00724*
Is	0.00524	-0.0120	-0.0277**	0.0305	0.0492	0.0177**

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	(1) North China	(2) East China	(3) Northeast China	(4) Central and South China	(5) Southwest China	(6) Northwest China
Fes	-0.0732	-0.0398	-0.129**	-0.0587	0.0628	0.158***
As	0.0579	-0.0160	-0.127	0.206***	0.0273	0.136**
cons	0.248	0.00830	-0.196	-0.839	-2.123*	0.206
Sample size	40	56	24	48	32	40

Note: *** $P < 0.01$, ** $P < 0.05$, and * $P < 0.10$

The impact of digital economy expansion on the income of urban and rural populations varies across different regions. In North China and East China, the development of digital economy is conducive to narrowing the urban-rural income gap, which is in line with the results obtained from the benchmark model. In Northeast, Northwest, and Southwest China, the effect of digital economy development on rural-urban income disparity is insignificant, probably because these three regions are at a disadvantage in terms of digital economy infrastructure, digital industry development, talent pool, resource endowment, and regional economic development compared to the former two regions. On the other hand, in Central and South China, digital economy development widens the urban-rural income gap. This indicates that a "digital divide" has emerged in this region.

4.3.3. Robustness test

We winsorized the predicted variable, Dig, at 1%, and then conducted regression by the two-way fixed effects model. As shown in **Table 5**, column (2), the coefficient of the predicted variable was still significantly negative, with a coefficient of -0.1480. Since the level of digital economy development in Beijing and Shanghai is significantly higher than other provinces, municipalities, and autonomous regions in the original data, we repeated the regression on the panel data after excluding the samples from these two places. The results are shown in **Table 5**, column (3), in which the coefficient of the predicted variable, Dig, was still significantly negative, with a coefficient of -0.151. This indicates that the results of the empirical analysis are robust.

Table 5. Robustness test results

	(1)	(2)	(3)
Dig	-0.1479***	-0.1480***	-0.151***
Eco	0.0305	0.0294	0.0260
Edu	-0.00513	-0.00506	-0.00118
Is	-0.0101	-0.00991	-0.0190
Fes	-0.0202	-0.0226	-0.0253
As	0.0125	0.0115	0.0343
cons	-0.137	-0.125	-0.119
Regional fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
Sample size	240	240	224

Note: *** $P < 0.01$, ** $P < 0.05$, and * $P < 0.10$

5. Conclusion

This study provides an empirical analysis using the data from 30 provinces and other provincial areas in China between 2013 and 2020 and concludes the following: firstly, digital economy helps in promoting rural-urban income equality in China; secondly, the effect of digital economy on the rural-urban income disparity in China is regionally heterogeneous, significantly bridging the income gap in East, North, and Northeast China.

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Disclosure statement

The authors declare no conflict of interest.

Author contributions

S.Z. conceived the idea for the study; Y.D. collected and analyzed the data as well as wrote the paper.

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