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Digital Economy Development and Urban-Rural Income Gap in the Context of Rural Revitalization

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Abstract

Based on The relationship between digital economy development and urban-rural income gap in the context of rural revitalization is analyzed based on provincial panel data of 31 provinces in China from 2010 to 2020. The results show that the overall relationship between digital economy and urban-rural income gap is "inverted U type" relationship. When the level of human capital is low, innovation is weak and urbanization rate is low, the digital economy will widen the urban-rural income gap; while when the level of human capital is high, innovation is strong and urbanization rate is high, the digital economy will narrow the urban-rural income gap. The regression results of the impact paths show that the digital economy can reduce the urban-rural income gap through three paths, namely, raising the level of human capital, enhancing innovation dynamics, and The regression results show that the digital economy can narrow the urban-rural income gap through three paths: improving human capital, enhancing innovation dynamics, and promoting urbanization.

Keywords

Rural Revitalization; Digital Economy; Urban-Rural Income Gap; Parallel Multiple Mediating Effects.

1. Introduction

Since the reform and opening up, China's economy has developed rapidly, but the problem of large rural income disparity has also emerged. The Fifth Plenary Session of the 18th CPC Central Committee put forward the implementation of the "National Big Data Strategy", and since then, China's policies to promote digital transformation and digital economy development have been deepened and implemented, and the scale of China's digital economy has been expanding and its contribution rate has been increasing. According to the White Paper on China's Digital Economy Development (2021), the value added of China's digital economy will account for 38.6% of GDP in 2020, reaching 39.2 trillion yuan. So, can the rapidly growing digital economy become an important step in narrowing the income gap between urban and rural areas? What are the impact paths? These questions deserve further in-depth study.

2. Literature Review

Currently, there are two broad approaches to measuring the digital economy.

One is direct measurement, which is to estimate or count the total amount and scale of digital economy in a specific region within a certain range (e.g., Xu Xianchun and Zhang Meihui, 2020); the other is comparative measurement, which is based on comprehensive evaluation indexes to compare and analyze the development level of digital economy in each region and derive the relative development of digital economy in each region (e.g., Wei, 2020). The discussion of the urban-rural income gap and its influencing factors has been an enduring research theme in academia, with influencing factors such as the degree of external openness (Liu Jun et al., 2015; Li Hong et al., 2019), industrial structure (Wu Wanzong et al., 2018), urbanization (Yuan, 2020),

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and infrastructure (Yang Xi and Shi Daqian, 2019) being the focus of academic research in recent years. There is now a basic consensus among academics that the digital economy can promote income increase (Zhang, Li et al., 2021), but there is still disagreement about the relationship between the digital economy and the urban-rural income gap. Yi Li and Jiesheng Ke (2021) argue that although the digital economy has increased farmers' income, at the same time, due to the lack of digital technology application skills among rural residents, the physical, social and human capital heterogeneity, the development of the digital economy has instead widened the urban-rural income gap (Correa et al., 2018). In contrast, Zhang Xun et al. (2019) hold the opposite view, arguing that rural residents will benefit more from the dividends brought by the digital economy than urban residents due to the new models of Internet education and digital inclusive finance, information sharing and dissemination mechanisms, employment and entrepreneurship opportunities, etc., thus reducing the income gap between urban and rural residents (Parker, 2011). Some other scholars argue that the digital economy and the urban-rural income gap are not simply The relationship between digital economy and urban-rural income gap is not a simple linear one, but may be "U" shaped (Wang, Jun, and Xiao, Huatang, 2011). 2021), and possibly an "inverted U-shaped" relationship (Li, Xiaozhong, and Li, Junyu, 2022). (Li and Li, 2022).

Compared with the existing Compared with the existing studies, the differences of this paper are explored as follows: First, in the comparative measurement of digital economy, the digital economy evaluation index system is constructed from four dimensions of ICT primary application, digital infrastructure, digital industrialization, and industrial digitization according to the definition of the connotation of digital economy by the China Academy of Information and Communication Research, and combined with the industries to which the digital economy belongs. Second, we explore the non-linear relationship between digital economy and urban-rural income gap from three perspectives: human capital, innovation dynamics, and urbanization, which complements the theoretical and empirical studies on the non-linear relationship between digital economy and urban-rural income gap. Third, the parallel multiple mediating effects model is used to analyze the three paths through which the digital economy affects the urban-rural income gap through human capital, innovation dynamism, and urbanization, which enriches the study of the impact paths of the digital economy on the urban-rural income gap.

3. Theoretical Analysis

3.1. The Digital Economy is Conducive to Promoting the Implementation of the Rural Revitalization Strategy Reduce the Income Gap between Urban and Rural Areas

Doing a good job in the "three rural areas" is an important landing point of the rural revitalization strategy (Yang Hui, 2019). Rural areas are very different from urban areas in terms of economy, culture and ecology due to a series of problems such as remote location, lack of convenient road transportation and backward educational resources. The development of the digital economy has brought advanced digital technologies, numerous jobs, high-quality educational resources, and promising entrepreneurial opportunities to rural areas. The penetration rate of Internet and mobile devices in rural areas is increasing year by year, with electricity in every home and Internet in every village, and ICT primary application capabilities of rural residents are rapidly increasing. Rural youths can receive the same quality of education as in towns through online classes. Some rural residents have joined the ranks of rural e-commerce, and despite their remote location, agricultural products have been able to maintain a steady increase in sales price and volume. Driven by the development of digital economy, rural areas have not only revitalized their culture, education and technology, but also their

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economy, rural residents' income has increased and become more stable, and the income gap between urban and rural areas has been narrowing.

3.2. Digital Economy Development has a Non-Linear Relationship with Urban-Rural Income Gap

In the In the initial stage of the digital economy, due to the existence of the urban-rural human capital gap and the digital divide, coupled with the fact that the benefits generated by innovation will be enjoyed by a few high-income earners in cities and towns, the large amount of surplus labor in rural areas will not have more suitable employment and entrepreneurial opportunities, and rural residents will not be able to make full use of the digital economy resources to improve their income compared with cities and towns, the digital economy will widen the urban-rural income gap at this stage. In the long run, as the development of the digital economy enters a mature stage, the digital economy will become more "inclusive", and both urban and rural areas will enjoy the dividends brought by the development of the digital economy. Technology The development of technology has led to an increase in the level of human capital in rural areas, and the spillover effect of innovation has enabled rural residents to enjoy the benefits of innovation, while the development of the digital economy has brought a lot of employment and entrepreneurship opportunities for the remaining rural labor force. Due to the law of diminishing marginal utility, the marginal impact of digital economy development on income in urban areas will be gradually "overtaken" by rural areas, and the income gap between urban and rural areas will be narrowed. Therefore, the relationship between digital economy development and urban-rural income gap is not a simple widening or narrowing relationship, but an "inverted U-shaped" non-linear relationship between the two.

3.3. The Digital Economy Reduces Urban and Rural Incomes through Three Paths: Improving Human Capital, Enhancing Innovation the Digital Economy Reduces the Income Gap between Urban and Rural Areas Through Three Paths: Improving Human Capital, Enhancing Innovation, and Promoting Urbanization. Income Gap

Digital Economy The economy can create learning conditions for urban and rural residents to enjoy rich educational resources more conveniently, and the breadth and depth of residents' knowledge reserves have increased, the level of human capital has risen, and the quality of the labor force has improved. Although in the early stage of development, a large number of talented people flocked from rural areas to cities and towns due to the high quality infrastructure and policy inclination in urban areas, making the human capital level in urban areas higher than that in rural areas. However, with the development of the digital economy, the human capital level of residents in both urban and rural areas has generally increased. According to human capital theory, the increase in the human capital level of rural residents will effectively increase the personal income of rural residents, thus narrowing the income gap between urban and rural areas. As an important production factor of the digital economy, the sharing of data will become an important engine to stimulate the vitality of innovation. The application of big data, the Internet and other technologies makes innovation more efficient, and the digital economy is the cradle of innovation in the new business model. Innovation can develop new technologies and improve production efficiency. Although the benefits generated by innovation will be enjoyed by high-income residents in cities and towns in priority when the innovation vitality is weak, with the increasing innovation vitality, the innovation spillover effect will bring more benefits to urban and rural residents, so that the income of rural residents can be effectively improved and the income gap between urban and rural areas can be further reduced. The digital economy era brings significant opportunities for China to promote the urbanization process. Digital infrastructure such as artificial intelligence, Internet of Things,

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and 5G are important grips in the urbanization process. Rural residents who have moved to cities for work after the reform of the household registration system can more easily enjoy the same medical and other social security as urban residents under digital governance and digital services, and the improvement of data collection and sharing capabilities helps rural surplus laborers more easily obtain opportunities to work in cities or even stay in cities on their own initiative. The development of the digital economy has accelerated the urbanization process, improved treatment and employment opportunities for farmers, which has helped to raise the income level of rural residents and narrow the income gap between urban and rural areas.

4. Model Setting, Variable Descriptions and Data Sources

4.1. Model Setting

To examine the impact of digital economy development on firms' innovation activities, the following benchmark regression model is developed.

$$Innovation_{it} = \beta_0 + \beta_1 + DigitalEco_{it} + \emptyset Control_{it} + \sigma_j + \gamma_k + \varepsilon_{it} \quad (1)$$

where the subscripts i, j, k and t correspond to firm, province, industry and year, respectively. The explanatory variable Innovation is the innovation output of enterprises, which is measured by the logarithm of the number of patent applications plus one (Patent_ap) and the logarithm of the number of patents granted plus one (Patent_au) with reference to the existing research practice, and the impact of digital economy development on the number of different types of patent applications and grants is also examined in this paper. The main explanatory variable (DigitalEco) is the level of digital economy development variable, which is mainly measured by using principal component analysis, specifically borrowed from Zhao Tao et al. (2020).Control is the set of control variables, including enterprise age (age), financial leverage (leverage), enterprise size (size), profitability (ROA), and cash flow level (cash). In addition, the model incorporates industry, province, and time fixed effects to mitigate the disturbance of potential industry and province characteristics with macroeconomic factors on the estimation results. ε is a random disturbance term to portray other non-specific factors. This paper focuses on the coefficient estimates and direction of the main explanatory variable (DigitalEco), which aims to portray the impact of the digital economy on firms' innovation activities.

4.2. Variable Selection

Explained variable is the income gap between urban and rural residents as measured by (Theil); the core explanatory variable is the level of digital economy development (DE) obtained from the comprehensive evaluation of entropy method; human capital (HC), innovation dynamism (CR), and urbanization (UB) are the threshold and mediating variables. Human capital (HC), innovation dynamism (CR), and urbanization (UB) are the threshold and mediating variables, where human capital is measured by years of education per capita; innovation dynamism is measured by the logarithm of the number of patents granted; and urbanization is measured by the ratio of urban resident population to total population. To reduce the bias caused by other neglected variables, the following control variables are selected: (1) Economic development level (ECO), measured by the logarithm of the real GDP calculated in 2010 as the base period; (2) (2) Investment level (Invest), measured by the logarithm of fixed asset investment; (3) Openness level (Open), measured by the logarithm of the ratio of total import and export to each province's regional GDP plus 1; (4) Fiscal expenditure (Finance), measured by the logarithm of the ratio of general public budget expenditure to each province's regional GDP plus 1; (5) Research investment (R & D), measured by the logarithm of R & D expenditure. (5) R & D, measured by the logarithm of R & D expenditures.

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4.3. Variable Measures and Data Sources

4.3.1. Digital Economy Development Level Measurement

Digital economy within The definition of the connotation determines the construction of the comprehensive evaluation index system of the development level of digital economy, including the following four dimensions: First, ICT application, the popularity of the Internet and digital media is conducive to the construction and development of digital society, and the demand of enterprises and residents for ICT applications is the basis of the development of digital economy. Second, digital infrastructure, the coverage of Internet broadband and base stations for enterprises and residents, the information and communication capacity of each region and the scale of web pages, etc. These will become important channels for the collection of digital information elements and digital transactions, and are important carriers for the development of the digital economy. Third, digital industrialization, the software industry, Internet industry, telecommunications industry, digital services and other information and communication industries are the core digital economy industries that completely rely on digital information elements and digital technology, and can provide digital products and digital services for the development of the digital economy. Fourth, industry digitization, traditional manufacturing and service industries benefit from digital technology and data empowerment to achieve digital transformation, further promoting the optimization and upgrading of industrial chains and production efficiency. Combining the characteristics of digital economy development in each province of China and taking into account the correlation and accessibility among the evaluation indicators, ICT application is mainly considered from the degree of telephone penetration, the scale of Internet users, the degree of Internet penetration and the degree of digital media penetration; digital infrastructure is mainly evaluated from the scale of web pages required for digital economy development, information and communication capacity, Internet and mobile base station coverage; digital industrialization is mainly considered from the Digital industrialization is mainly considered from the scale of manufacturing industry of electronic information industry, scale of telecommunication business, scale of software business, scale of digital services, and proportion of online retail sales; digitalization of industry The digitalization of industry is mainly considered in terms of the proportion of high-tech industry, high quality of service industry, production efficiency of high-tech industry, degree of enterprise informatization, digital finance, etc. Thus, a comprehensive evaluation index system of digital economy development level is constructed with ICT application, digital infrastructure, digital industrialization and industrial digitalization as the primary indicators and 18 indicators such as telephone penetration as the secondary indicators, and the entropy weight method is chosen to measure the above index system. Among them, the digital financial indicators are measured by the Digital Inclusive Finance Index of Peking University.

4.3.2. Data Sources and Descriptive Statistics

The provincial panel data of 31 provinces in China from 2010 to 2020 are selected, and the data are mainly obtained from the China Regional Economic Statistical Yearbook, China Tertiary Industry Statistical Yearbook, China Statistical Yearbook, China High Technology Industry Statistical Yearbook, Compilation of Science and Technology Statistics, China Science and Technology Statistical Yearbook, and the website of the Chinese Ministry of Education. Among them, the statistical caliber of the rural per capita net income indicator was changed to rural per capita disposable income in 2013, and the data of the rural per capita disposable income indicator from 2010 to 2012 were replaced by the rural per capita net income indicator due to the large gap between the two. Missing values were filled by regression interpolation.

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5. Empirical Analysis

5.1. Baseline Return

The Hausman test results for both model (1) and model (2) strongly reject the original hypothesis at the 1% level and should be estimated using a fixed The fixed effects model should be used for estimation. The results show that the development of digital economy has a significant positive relationship with the urban-rural income gap, i.e., the development of digital economy significantly widens the urban-rural income gap. The possible reasons are that urban areas, relying on their geographical location, human capital advantage, resource advantage and policy inclination, have better digital economy development than rural areas, and urban residents are more likely to use the digital economy dividend to increase their income compared with rural residents, which in turn leads to further widening of the urban-rural income gap. The results show that after controlling for a series of other variables, the primary term of digital economy has a significant positive relationship with the urban-rural income gap as in model (1), while the squared term of digital economy has a significant negative relationship with the urban-rural income gap, indicating an "inverted U-shaped" relationship between digital economy and urban-rural income gap as a whole. In other words, the development of digital economy will widen the urban-rural income gap within a certain period of time, but in the long run, the development of digital economy will eventually push the urban-rural income gap to narrow. This indicates that with the further development of the digital economy, the digital economy will become more "inclusive", and both urban and rural areas will enjoy the dividends brought by the development of the digital economy.

Both urban and rural areas will enjoy the dividends brought by the development of digital economy. Due to the law of diminishing marginal utility, the marginal impact of digital economy development on income in urban areas will gradually be overtaken by rural areas, and the income gap between urban and rural areas will gradually decrease. The robustness test after adding the control variable of public library collection per unit of population (Book), the coefficient, sign and significance of the regression results are not significantly different, and the regression results are robust. Considering the possible causal relationship between digital economy and urban-rural income gap, DH panel causality test is selected, and the judgments all reject the original hypothesis that there is a mutual causal relationship between the two sides, which will lead to the emergence of endogeneity To alleviate the endogeneity problem, DH panel causality test is selected.To alleviate the problem of endogeneity, the first-order term of digital economy lag is selected as the instrumental variable DE_iv, and the model is regressed again using two-stage least squares method, and the regression results are shown. There is a correlation between the instrumental variable and the independent variable, and there is no over-identification problem. The F-value of the weak instrumental variable test is greater than 10, and the hypothesis that the instrumental variable is a weak instrumental variable is rejected. After considering the endogeneity problem, the sign and significance of the regression results remain the same, the instrumental variables are chosen The instrumental variables are selected reasonably and the regression results are robust.

5.2. Panel Threshold Regression

with human capital, innovation The results of the threshold effect existence test with human capital, innovation dynamism, and urbanization as threshold variables. The results show that there is a threshold effect and there is a single threshold. The threshold thresholds of human capital, innovation dynamism, and urbanization are 9.113, 4.956, and 0.240, respectively, and a single threshold effect model is selected for human capital, innovation dynamism, and urbanization threshold variables. The results of the panel threshold regression estimation of the digital economy and urban-rural income gap are presented. It shows that the relationship

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between digital economy and urban-rural income gap is divided into two intervals by reasonable thresholds of human capital, innovation dynamism, and urbanization, respectively, and there are relatively significant differences between the different intervals. When human capital is at low level stage, the regression coefficient of digital economy development on urban-rural income gap is significantly positive with the coefficient value of 3.007; when human capital crosses the threshold threshold at high level stage, the regression coefficient of digital economy development on urban-rural income gap is -0.273. The possible reason is that when human capital is at low level, although the development of digital economy brings advanced digital The development of digital economy widens the urban-rural income gap at this stage because rural residents cannot make full use of the digital economy resources to improve their income compared with urban areas due to the constraints of infrastructure and education, etc. When human capital is at a high level, the proficiency of rural residents in using computers and mobile devices is closer to that of urban residents, and some rural residents join the ranks of rural e-commerce, the impact of digital economy development on the income of rural residents will be greater than that of urban residents, and the income gap between urban and rural areas will gradually narrow. The regression coefficient of the digital economy on the urban-rural income gap is 4.739 when the innovation vigor is weak, and -0.309 when the innovation vigor is strong. the possible reason is that when the innovation vigor is weak, the benefits generated by the innovation will be firstly occupied by the high-income people in the towns, and the rural residents can hardly rely on the benefits of the innovation to improve their income. The income gap between urban and rural areas keeps widening. When innovation is strong, due to the innovation spillover effect, the benefits of innovation are no longer exclusively occupied by the high-income earners, and rural residents can also enjoy the benefits of innovation, and their income keeps increasing, and the income gap between urban and rural areas keeps narrowing. When the urbanization rate is low, the digital economy has a significant positive impact on the urban-rural income gap; when the urbanization rate is high, the impact of the digital economy on the urban-rural income gap is significantly negative. The possible reason is that the digital economy dividend is first generated in urban areas, and in the early stage of urbanization, due to the household registration system, farmers who migrate to urban areas have difficulty in enjoying the same treatment as urban residents, and even less in enjoying the digital economy dividend, and the urban-rural income gap keeps widening. The increase of urbanization rate and the reform of household registration system have developed small and medium-sized On the other hand, farmers who migrate to urban areas can also enjoy urban public services, which is conducive to the improvement of rural residents' income and the narrowing of the urban-rural income gap. After regressing the threshold model, the robustness test was conducted by supplementing the omitted variables and replacing the explanatory variables. Considering that public library collection per unit of population (Book) can also have an impact on the urban-rural income gap, this indicator is added to the control variables for robustness testing; the explanatory variable is replaced with urban-rural income ratio for further robustness testing, and the findings of the study still hold, and the panel threshold regression results are robust and reliable.

5.3. Parallel Multiple Intermediation Effect Analysis

The above empirical findings show that the development of the digital economy significantly increases the innovation output of regional enterprises, as manifested by the increasing number of patent applications and patents granted. Further, this part attempts to analyze in depth the impact of digital economy development on enterprise innovation activities from multiple perspectives, including the R&D end of enterprise innovation activities, innovation structure, innovation quality and cooperative innovation behavior, in order to enrich the community's understanding of the relationship between digital economy and enterprise innovation activities.

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Sobel test results show that human capital, innovation dynamics, and urban The three variables of urbanization all have mediating effects. Digital economy development The regression results of the path of impact on urban-rural income gap. The regression results of the total utility of digital economy on urban-rural income gap, the regression coefficient of total utility is -0.341, and it is significant at 99% confidence interval, indicating that the development of digital economy can reduce the urban-rural income gap in general. The regression results of the digital economy on the parallel mediating variables human capital, innovation dynamism, and urbanization, respectively, the regression coefficients of the digital economy on the three parallel mediating variables are 0.922, 0.800, and 0.370, which are significant at 90%, 99%, and 99% confidence intervals, respectively, indicating that the development of the digital economy can improve the level of human capital, enhance innovation dynamism, and promote the urbanization process. It is the regression result of the effect of digital economy on urban-rural income gap after introducing parallel mediating variables, and the regression coefficient is -0.199 and significant at 99% confidence interval, i.e., there is a direct effect. The regression coefficients of human capital, innovation dynamism, and urbanization on urban-rural income gap are -0.046, -0.024, and -0.726, respectively, all of which are significant at 99% confidence interval, indicating that the increase in human capital level, innovation dynamism, and urbanization rate can significantly reduce the urban-rural income gap to different degrees. There are partial mediating effects of human capital, innovation dynamics, and urbanization, and the total indirect effect accounts for 49.13% of the total effect. The ratios of indirect effects to total effects are 6.26%, 2.85%, and 40.02%, respectively, implying that the digital economy can reduce the urban-rural income gap through the three paths of improving human capital, enhancing innovation dynamics, and promoting urbanization, respectively. In order to test the reliability of the regression results of parallel multiple intermediation effects, the regression results of parallel multiple intermediation effects analysis are re-run by replacing the explanatory variables with urban-rural income ratios, and the sign direction and significance of the regression results do not differ significantly, indicating that the results of parallel multiple intermediation effects analysis are robust and reliable.

6. Key Research Findings and Policy Implications

The relationship between digital economy development and urban-rural income gap in the context of rural revitalization is analyzed based on provincial panel data of 31 provinces in China from 2010 to 2020. The relationship between digital economy development and urban-rural income gap in the context of rural revitalization is analyzed based on provincial panel data of 31 provinces in China from 2010 to 2020. The results show that the digital economy and the urban-rural income gap have an overall "inverted U-shaped" non-linear relationship. When the level of human capital is low, innovation is weak, and urbanization rate is low, the development of digital economy will widen the urban-rural income gap; while when the level of human capital is high, innovation is strong, and urbanization rate is high, the development of digital economy will narrow the urban-rural income gap. The regression results of the impact path show that the digital economy can narrow the urban-rural income gap through three paths of enhancing human capital level, strengthening innovation vitality, and promoting urbanization process, respectively. Based on the above findings, the following recommendations are made: First, the digital infrastructure should be increased to make up for the shortcomings. Strengthen the construction of digital infrastructure such as big data center, 5G network, Internet of Things and other infrastructure to provide strong support for the development of digital economy. Second, improve the level of human capital and establish a sound system for training digital technology talents. Based on the "Talent Power Strategy", we should make great efforts to reserve digital talents, establish a sound multi-dimensional and diversified digital technology talent training system, improve the depth and breadth of education for rural

residents by relying on the convenience and speed of digital technology, and raise the level of human capital in rural areas. Third, the digital economy will lead innovation and development, and accelerate the construction of digital industrialization and industrial digitization. We will stimulate innovation, raise people's awareness of copyright, improve the legal system of intellectual property rights, and accelerate the construction of innovation support mechanisms and innovation training and education. Fourth, take the digital economy era as an opportunity to accelerate the construction of new urbanization. Sound digital governance and digital service system, accelerate the construction of public employment service information platform, and improve the service capacity and management level of employment of rural residents in urban areas. Fifth, make full use of the wave of digital economy development to comprehensively promote the rural revitalization strategy. Through the introduction of advanced digital technology and management and governance experience, we will accelerate the modernization of agriculture and rural areas and improve human capital in rural areas. We will improve the level of human capital and entrepreneurial vitality in rural areas, solve the employment and entrepreneurship problems of the remaining rural labor force, increase the disposable income of rural residents, and comprehensively promote rural economic revitalization, education revitalization, cultural revitalization, and ecological revitalization by relying on the digital economy.

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