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Has Digital Village Construction Narrowed the Urban–Rural Income Gap: Evidence from Chinese Counties

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Abstract: Can the backward endowments of rural areas support digital village construction to attain the expected results? If the answer is yes, what are the mechanisms involved? Answering these questions is related to common prosperity. Counties are China's frontline commanders, and the urban–rural income gap is a suitable entry point for observing the urban–rural digital divide; however, there is limited research assessing the effectiveness of digital village construction from the perspective of the urban–rural income gap at the county level. In addition, counties lifted out of poverty, as counties with worse initial endowments and as counties that should be most concerned with common wealth, are more typical for examining the effectiveness of digital rural construction; however, there are few studies on counties lifted out of poverty. Based on cross-sectional data from 865 counties in China in 2020, this study empirically analyzes the impact of digital village construction on the urban–rural income gap using an OLS model. This study also conducts mechanism tests and poverty benefit tests in addition to heterogeneity and robustness tests. The findings indicate that the development of digital villages lowers the income difference between urban and rural areas, and that the shift in the industrial structure is a key driver of this effect. Different construction dimensions have varying degrees of impact, with digital infrastructure and the digitalization of the economy having the most significant impact, the digitalization of countryside governance coming second, and the digitalization of countryside life having the most negligible impact. The impact is more pronounced in the central-eastern region of China and counties that have just been lifted out of poverty than in the western region and counties that have never been in poverty. The government will benefit greatly from this study's understanding of the main themes, areas, and scope of digital rural construction, which will help to expand and further integrate the outcomes of reducing poverty and fostering shared prosperity.

Keywords: digital village construction; urban–rural income gap; industrial structure; poverty alleviation; sustainability

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1. Introduction

The twentieth CPC National Congress report pointed out that the principal contradiction in Chinese society is between the growing need for a better life and unbalanced and insufficient development. The most enormous imbalance is between urban and rural development, and the biggest insufficiency is rural development. China's urban–rural income multiplier still reached 2.5 in 2021, meaning that while the country's income disparity has been narrowing annually, urban inhabitants' disposable income was still 2.5 times greater than that of rural ones. The Gini coefficient was higher than the global warning line of 0.4 at the same time, at 0.466. Achieving socialist modernization requires achieving the goal of narrowing the income gap between rural and urban areas, which is essential to achieving common prosperity. Narrowing the income gap between urban and rural areas and achieving common prosperity in China requires acknowledging the reality of the country's large wealth disparity between the rich and poor. It should be made clear that

balancing development between urban and rural areas is not a matter of "subtracting" from the affluent groups and regions, but instead of "adding" to the less affluent groups and regions and paying more attention to and supporting the development of rural areas. As a new lever to pry the global economy, the digital economy is vital in promoting economic transformation and upgrading, cultivating new economic momentum, and building new competitive advantages against sluggish global economic growth. Accenture estimates that for every 10% rise in digitization, GDP per capita increases by 0.5% to 0.62%, and that by 2050, the digital economy will account for more than 50% of the global economy [1]. At the same time, the digital economy provides a valuable opportunity for China to change lanes and overtake in the fourth industrial revolution and is of great strategic significance for realizing high-quality development and the great rejuvenation of the Chinese nation [2]. China's digital economy was worth over 41% of the country's GDP in 2022 and it is already one of the key drivers of economic expansion. However, different regions and groups have different initial endowments, and their ability to utilize the digital economy varies considerably; the invisible digital divide puts developed and backward areas into the fast and slow lanes, respectively. Therefore, because of the digital divide, the digital economy, which is focused on fostering growth and stabilizing development, has the potential to worsen the uneven development of urban and rural areas. If the gap between urban and rural areas is widened, it will not only reduce the sense of well-being and fairness of rural residents, but also threaten the harmony and stability of the whole society; this stability is the goal of China's social construction, so narrowing the gap between urban and rural incomes has always been an important task for China's society.

Digital village construction has been viewed as a key component of digital China and a strategic direction for rural revitalization. It has generated a number of innovations, including smart agriculture and rural e-commerce, and is expected to close the income gap between urban and rural areas as well as bridge the urban–rural digital divide. Since 2005, the No.1 document of the CPC has put forward "Strengthening Agricultural Informatization Construction", which means that the coupling construction of agriculture with informatization and networking has been given high priority and incorporated into the top-level design of the country. China's Eleventh Five-Year Plan has made it a top priority to strengthen the development of agricultural informatization, achieve the docking of small farmers' production with the big market, and reduce the "digital divide" between urban and rural areas through improved informatization. The No.1 document of the CPC formally put forward the idea of strengthening the construction of agricultural informatization in 2016, which is the key to the modernization of agriculture and indicates the new direction and trend of modern agricultural development. In 2018, the CPC No. 1 document formally proposed the "implementation of the digital village strategy" and initiated the digitalization of the village. This entails broadening digitalization's application scope beyond the "agricultural field", which was the primary focus during the concept stage, to include the "livelihood protection field", which includes rural residents' access to healthcare and education. The construction of the digital countryside has been rapidly spreading in China since then. The "Outline of the Digital Village Development Strategy" published in 2019 made it apparent that the digital rural development plan is a cutting-edge method and movement. The Outline makes it clear that the objective of the digital countryside strategy is to bridge the "digital divide" between urban and rural areas and to enhance farmers' digital literacy, in addition to emphasizing the "access" of digital infrastructure and service platforms. With the successive introduction of digital village construction policies, counties can act based on their conditions to spread the relevant construction, but there are differences in the vigor and orientation of each county's digital village development. Concurrently, the relevant state departments should monitor the trend of a set of uniform documentation and the implementation of 2020 to implement the construction of the county digital village pilot project. They should also investigate the route to construction, address potential hazards during construction, lower construction costs, and enhance the effectiveness of crucial steps in the construction process. It is important to acknowledge that a number of typical

cases have been developed in real-world settings through encouraging the integration of digitalization with rural economic and social development, improving farmers' access to contemporary information, and advancing the modernization and transformation of rural and agricultural areas. For example, Deqing County in Zhejiang Province has created a model called "digital village in one map", relying on the dynamic and visual "twin mirror map" and "data collection pool" containing 282 types of essential information to provide automatic generation of analysis reports, alarms for abnormalities, and other services; it is not only the village "data actuary", but also the village "intimate housekeeper" [3]. Shandong Zichuan District built an intelligent mushroom production workshop, relying on the 5G network for real-time data collection, transmission, and mining analysis to form an artificial intelligence to assist decision-making, enhancing production efficiency by four times and reducing operating costs by 30% [4].

Despite the existence of successful typical cases, the resource endowments and development capacities of different counties and regions in China vary greatly, and the digital literacy of the majority of rural residents has "fallen behind", so it is questionable whether the effectiveness of individual typical cases in rural areas can be replicated nationwide. Different forms of combining digital technology with agriculture and rural areas have different impacts on the income gap between urban and rural areas. The ways in which digital technology is incorporated into agriculture and rural areas have varying effects on the disparity in income between urban and rural communities. Taking the most typical Chinese e-commerce platforms moving into the countryside in recent years as an example, on the surface it seems that all farmers who become sellers can make more money in their pockets through the channel of e-commerce, but in essence the sellers who really benefit from it need to solve the two major problems of homogenization of agricultural products and asymmetric information, which requires increased investment in advertising of agricultural products to make it look more reliable, increase the network exposure and viewership so that the agricultural products can be sold with a higher probability, and be able to communicate well with consumers and "buy" them to give positive feedback for their products. Achieving any of the above requires the seller to have specific human capital, which is very difficult for a single farmer to achieve. Sellers of agricultural products with these endowments are often backed by capital or specialized firms from the cities. Rural residents with low digital literacy tend to lose out in this "business war", or even lose money and leave the market. In other words, the biggest beneficiaries of digital village construction may not be rural residents. Huang et al.'s results from a stratified random sample of farmers in eight provinces in China in 2022 indicate that less than 1% of farmers sell agricultural products directly online, with sales accounting for only 0.3% of their total household sales of agricultural products [5]. This confirms that the concern about whether the biggest beneficiaries of digital village construction are farmers is necessary. At the same time, the construction of digital villages involves a wide range of areas, is a heavy task and has a long period of time, and requires a large amount of capital to be invested over a long period of time, so the construction costs are enormous. Determining the direction and magnitude of the influence of digital village development on the disparity in income between urban and rural areas is of utmost urgency. Understanding the effect mechanisms is essential to understanding the future course of digital village development and the sustainable growth of rural communities.

Based on this, using the "urban–rural income gap", which serves as the fundamental lens through which to see the urban–rural digital divide, as a starting point, the primary goal of this study is to assess the digital village construction policy using both theoretical and empirical evidence. This has multiple goals. The first goal, and the one that worries us the most, is to determine if the development of digital villages would close the economic gap between urban and rural areas. If it is not narrowed, it will mean that a large amount of money invested in rural areas is wasted or more dividends are enjoyed by urban residents, because although the place where the policy is implemented cannot be moved, the better endowed urban residents can move to the rural areas where the policy is tilted. Second,

what are the ways that the urban–rural income divide is impacted by digital rural construction? Third, which digital rural construction focus—rural digital infrastructure building, rural economic digitization, rural governance, or rural life digitization—is most effective in addressing the disparities in its effects on the urban–rural income gap? Fourth, given the vast contrasts in China's eastern, central, and western regions' natural resources, economic development, and cultural views, how does digital rural construction affect the disparities in urban–rural income between these regions? Fifth, although China has completed a program of comprehensive poverty eradication in 2020, there are huge differences between the initial endowments and development capacities of poverty eradication counties and never-poor counties; will digital village construction affect them differently? At present, China's digital village construction is still in the process of exploration and standardization for continuous improvement; in this process, researching the efficacy and methods of building digital villages is a promising endeavor. This study's conclusions are crucial for the government to understand the main approaches, scope, and areas of building digital villages. They also help to expand and consolidate the outcomes of rural revitalization and poverty alleviation, encourage the sustainable development of rural areas and the poor, and advance shared prosperity.

The remainder of this research is structured as follows: The literature review and marginal contributions are presented in Section 2; the theoretical analysis and main research hypotheses are formulated in Section 3; the materials and methods are covered in Section 4; the empirical results and analysis are covered in Section 5; the discussion is covered in Section 6; and the conclusion is covered in Section 7.

2. Literature Review

Looking around the world, the development of digital villages is comparatively advanced in most wealthy nations. The United States has established a relatively perfect digital village construction system, including capital investment in building rural networks, legislation to guarantee Internet security and other basic measures, as well as emphasizing rural education, the research and development of agricultural production technology, and the development of agricultural e-commerce [6]. As a typical illustration of the relative dearth of rural resources, Japan focuses on the building of an information service system under government guidance as part of the construction of digital villages, with the goal of improving the efficiency of agricultural resource units. Compared with the former two, smart village construction in Europe is more aimed at solving the various problems and challenges that village residents may face in the 21st century. For example, in the UK, one of the countries with the highest urbanization rate in the world, the main focus is on the government's launching of the £200 million Rural Gigability Connectivity (RGC) program to solve the problem of rural education, as well as the UK government's promotion of network operators reducing the cost of building rural communities in the form of commercial competition [7].

In contrast, China's digital village construction has drawn on the experiences of many developed countries. Regarding the policy evaluation of the success of China's development of digital villages, there are still, nevertheless, divergent opinions within the academic community. One viewpoint is that digital rural construction can benefit rural areas by introducing emerging elements and activating traditional aspects in rural areas. Digital rural construction, according to Wang et al., is the creation of a virtual space that is twinned within the "physical world" and the "digital world", enhancing rural regions' capacity for production and quality of life through the generation, activation, and amplification of a variety of activities [8]. Shen and Yuan used Ostrom's theory of autonomous governance to elucidate the practical logic of digital villages from five dimensions: behavioral motivation, institutional support, resource supply, public participation, and supervision mechanism [9]. Building digital villages, according to Zeng et al., is a process of modernizing and developing agriculture and rural areas by promoting general planning and support, encouraging the widespread application of modern information technology in the economic and social

development of agricultural and rural areas, and enhancing the endogenous development of rural power through raising rural residents' levels of modern information literacy and skill [10]. Regardless of perspective, this boils down to the belief that digital village construction can create innovation or transform and upgrade the elements of rural areas. Another opposite viewpoint expresses doubts and concerns that rural areas' backward endowment conditions are incompatible with advanced digital construction. Based on the analysis of the feasible ability framework, Lv found that rural residents lack the opportunity and ability to obtain information, specifically including the possibility of information production, the accessibility of information access, the affordability of information payment, and the know-how of information use, and that the information divide generated by these aspects hinders the construction of digital villages [11]. Wang et al. think that the money needed to build digital villages is a bigger issue than just the caliber of rural residents; China's rural and sparsely populated areas coexist, and long-term backwardness and weakness are significant [8], necessitating long-term, continuous investment in the development of digital villages.

Digital countryside construction is still in its infancy [12] and to grasp its development trend and law more deeply, it is necessary to start from its essence. The digital economy combined with rural areas, agriculture, and farmers is the essence of digital rural construction; nevertheless, the academic community cannot agree on how the digital economy affects the distribution of income between urban and rural areas. Numerous academics focus on the "digital dividend" that results from the digital economy's shift from traditional to digital factors of production and hold the view that the digital economy has a "universal benefit" [13]. This means that through the long-tail, network, scale, and scope economies, it can increase the "latecomer advantage" of rural areas by closing the income gap between them and metropolitan areas [14,15]. Firstly, the digital infrastructure centered on "digital plus infrastructure" differs from the traditional "iron and public infrastructure". Various digital platforms based on digital technology have been added which can play an essential role in production, sales, and distribution. This is conducive to the digital upgrading of agriculture and rural e-commerce development [16], bringing opportunities for inclusive growth in rural areas [17]. Secondly, the digital economy has the advantage of reducing search, replication, transportation, and verification costs [18]. Its development reduces rural residents' information constraints [19], increases their non-agricultural employment opportunities and the accessibility of digital financial products, raises human capital and entrepreneurial activity in rural areas [20–22], alleviates the "Matthew effect" of traditional human capital and financial services, and is conducive to the realization of the commonwealth.

There are many of academics who disagree, but the digital economy depends on the initial factor endowment imbalance between urban and rural areas to create a "digital divide" that cannot be ignored. They contend that urban residents will gain more from the "digital dividend" because they will have access to and be able to use the realities of the conditions of both the urban and rural digital economies, while rural residents' self-exclusion and tool exclusion characteristics will dilute the benefits of the digital economy [23], increasing the income gap. Existing data mainly focus on the access and utilization of digital economy infrastructure. On the one hand, according to data from China's Ministry of Industry and Information Technology, China's 4G network covered all cities in 2016, while the proportions of administrative villages, impoverished villages, and deeply impoverished areas in the "Three Regions and Three Prefectures" that had access to broadband at that time were, respectively, less than 70%, 62%, and 26%. This vividly illustrates that the Internet development between urban and rural areas was not balanced [24]. Differences in the availability of digital infrastructure and services directly lead to the urban–rural digital "access" divide [25]. Nonetheless, differences in digital literacy between urban and rural populations account for the urban–rural digital "use" divergence [26]. Based on work search theory, He and Xu found that there has been a rise in the income difference between urban and rural areas as a result of variations in the Internet access abilities of urban and

rural inhabitants [27]. For urban individuals, the Internet has resulted in a 20% return on income; however, for rural residents, this return is negligible [28].

Additionally, some academics note that as the digital economy continues to develop, its link to the wealth difference between urban and rural areas will likewise vary dynamically and eventually take on a non-linear form. There are two main types of trends, one of which is a U-shaped curve opposite to the Kuznets curve. For example, Fan et al., believe that the early digital economy is mainly promoted with low requirements for knowledge and skills, and the low human capital labor force can be competent [13]. It is becoming more and more difficult for rural inhabitants to compete in digital sorts of work due to the strong integration of industry and digital technologies. Xu and Liu have also obtained similar conclusions based on the Baumol–Fuchs hypothesis [29]. The other category shows an inverted U-shaped curve similar to the Kuznets curve. For example, Cheng and Zhang [30] think that rural people exhibit clear deficiencies in the gathering, identifying, using, and reprocessing of information throughout the early phases of the digital economy's development. The ability of people living in rural areas to remain relevant has steadily improved as technology has advanced. The income disparity between rural and urban dwellers has a propensity to increase, reduce, and then climb again; in 2009, China crossed that threshold.

Looking at the above, it is possible to identify the flaws of the current literature and the study's marginal additions. First, there are two or more opposing viewpoints in the existing results. Whether it be on the evaluation of digital village policies or the effect of the digital economy on the income gap between urban and rural areas, the literature currently in publication only addresses the reasons behind disagreements regarding the data, study period, and indicator construction methodology [31]; it does not address these issues at a deeper level. In order to address this shortcoming, this paper acknowledges that all points of view essentially agree that the digital economy and digital construction can bring "digital dividends." The central questions in the debate are whether or not rural residents can share these "digital dividends", how much they can share, and whether or not the amount of sharing will decrease as the digital economy develops. The theoretical and empirical problems about the aforementioned divergent arguments, as well as the questions regarding how rural dwellers can benefit from the "digital dividend", will be addressed in the section that follows in this study.

Secondly, there is a relative gap and a need to supplement the articles related to evaluating China's digital countryside construction from the perspective of the urban–rural income gap, and this research topic is very necessary because the urban–rural income gap is an important entry point to observing the urban–rural digital divide. Only very little literature has focused on this point. From a micro-farmer perspective, Yin and Sun investigate how the income gap among rural residents is affected by digital rural construction. They discover that there is an elite capture phenomenon associated with this phenomenon and that farmers who have higher levels of social capital and education are more likely to reap the benefits [32]. On this basis, Li and Li focus on the topic of the urban–rural income gap and conclude that digital rural construction produces an inverted U-shaped trend on the urban–rural income gap [33]. Regretfully, though, the empirical evidence presented in this article does not account for demographic variables like the population's educational attainment and the region's age, which have a significant impact on the income gap between urban and rural areas. Moreover, the theoretical analysis presented here confuses the development of digital technology in wider areas with the implementation of digital village construction in rural areas, concentrating only on the digital aspects of the policy and neglecting its key feature that sets rural-oriented policies apart from other digitization initiatives. Because of this, the paper's control variables include aging and education levels at the county level, which are examined in the theoretical analysis with a particular emphasis on the context of digital rural construction.

Third, the paper further focuses on the performance of digital village construction in the counties that have been lifted out of poverty. All Chinese counties were lifted out of poverty by 2020, and consolidating the results of poverty eradication is the biggest

focus of the Chinese government's current poverty reduction efforts. There are two major differences between counties that have been lifted out of poverty and those that have never been poor before: First, the initial endowments and development capacities of counties that have been lifted out of poverty are worse; second, the Chinese government advocates the principle of "help the horse and give it a ride", which is a transitional period for poverty alleviation until 2025. Whether digital village construction can play a role in poverty alleviation requires additional attention. However, this part is missing in the existing literature. The research in this paper contributes to the enrichment of poverty alleviation theory and empirical evidence.

3. Theoretical Analysis and Research Hypotheses

Digital village construction is proposed based on rural areas and benchmarking against cities [10]. Promoting the integration of rural development and the digital economy is at the center of it all. To put it simply, the government is spearheading the creation of a digital countryside through modernizing historic components found in rural areas, bringing in new components, encouraging pertinent effects to propel companies and jobs, and reducing the economic disparity between urban and rural areas. From a surface logic perspective, building digital villages encourages the spread of digital platforms and infrastructure in rural areas, thereby bridging the digital "access divide" that exists between urban and rural areas. On the other hand, by providing digital education and re-education, rural residents' digital literacy will be enhanced, thus bridging the digital tool "use gap" between urban and rural areas. Among them, effective "use" is the prerequisite for more "access" to work [18]. When digital infrastructure is ahead of rural residents' digital literacy, it will stimulate a complementary effect, drive rural residents to improve their digital literacy to adapt to the digital infrastructure, and prompt the digital infrastructure to play its proper role. When the digital infrastructure is ahead of the digital literacy of rural residents, the supporting effect is stimulated, driving rural residents to improve their digital literacy and adapt to the digital infrastructure so that the digital infrastructure can play its proper role. There is an implicit mechanism: Digital village construction has the characteristics of a digital economy and policies oriented toward rural areas which encourage creation, matching, and multiplier effects and lessen the income gap between urban and rural areas. This is achieved by introducing and reorganizing factors and concentrating on industries and employment that are most closely related to incomes (see Figure 1).

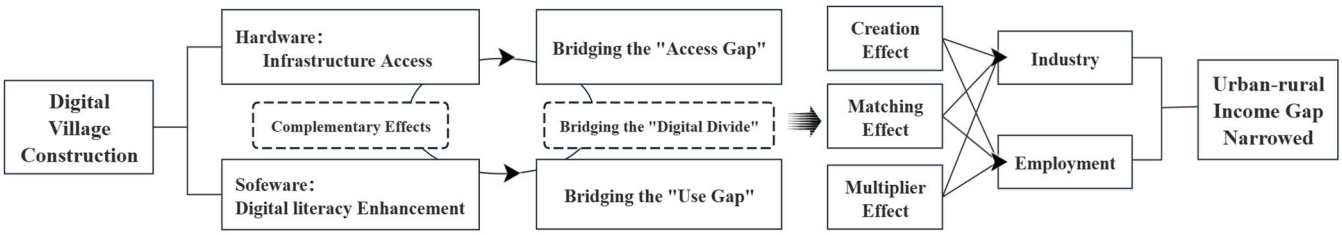


Figure 1. Mechanisms for reducing the urban–rural income gap through digital village construction.

The "creation effect" of building digital villages has reduced the income disparity between urban and rural communities. According to Schumpeter's innovation theory, the construction of digital villages has led to the recombination of digital production factors with traditional production aspects in rural areas, creating new opportunities for economic growth in rural areas. From an industrial perspective, the first is to promote the transformation and upgrading of the entire agricultural industry chain. Relying on new elements of agricultural production such as satellite remote sensing, agricultural drones, and digital service platforms, digital village construction creates new forms of operation, overcomes the problems of traditional agriculture in production, circulation, production, and marketing, enhances agricultural total factor productivity, and accelerates the transformation of agricultural modernization [34]. Second, in rural areas, it has caused the establishment

of new business models. The development of digital villages has enhanced rural areas' digital infrastructure, promoted the linkage of online and offline circulation of factors, and lowered the average cost of the production sector through the scale effect [35], which has helped rural areas become a fertile ground for the reproduction of new forms of business, and the prosperous development of the rural e-commerce industry is a typical case in point. From the employment perspective, the construction of digital villages has created many employment opportunities. In addition to increasing job opportunities and pushing the employment of low-skilled laborers in rural areas, the process of building infrastructure has also given rise to related industries. On the other hand, the emergence of these new industries has created new job demands, resulting in the creation of hundreds of millions of flexible jobs like webcasters, e-commerce customer service representatives, couriers, and so on. These occupations often have more freedom and flexibility. They are suitable for both part-time and full-time jobs, diversifying rural residents' livelihoods and livelihoods and improving employment quality [36].

The "matching effect" can be used to reduce the income disparity between urban and rural areas while building digital communities. Amartya Sen's theory of feasible ability shows that poor people cannot escape the vicious circle of poverty due to wrong decision-making based on a lack of information, and this is an essential reason for the urban–rural income gap. The building of digital villages removes the "information cocoon" problem in rural areas [37], encourages the best possible distribution of labor and capital [38], and ultimately boosts economic growth in these places. From an industrial perspective, digital rural construction allows for the matching of the massive amounts of information released by rural and urban areas. In particular, it allows the urban side to receive and obtain large-scale data on the dynamics of rural development in the new era. This helps urban capital remove the "discriminatory" investment barrier that previously existed between older rural areas and urban areas [39]. This encourages the sharing and collaboration of resources between rural and urban areas, which in turn propels the modernization and development of rural industry. From the perspective of employment, firstly, the low use threshold and substantial knowledge spillover of digital technology provide rural residents with more training and self-education opportunities, which is conducive to efficiently matching the knowledge they need and upgrading their human capital. Secondly, based on the theory of search, digital job search channels enable enterprises and job seekers to fully disclose information on both sides, which saves the cost of on-site inspection, reduces the friction and loss caused by asymmetric information, and reduces the degree of individual employment mismatch [40], which is conducive to improving the degree of human-job matching and job satisfaction. In addition, the accurate push based on extensive data matching makes it easier for potential entrepreneurs in rural areas to identify entrepreneurial opportunities and obtain entrepreneurial services [41,42], which is conducive to increasing the entrepreneurial activity of the rural labor force and empowering the high-quality development of the economy in rural areas.

The "multiplier effect" of digital village development helps to close the income gap between urban and rural areas. In contrast to the "urban-oriented" strategy, which prioritizes efficiency, the building of digital villages falls under the "rural-oriented" policy, which prioritizes equity. This implies that financial resources will be allocated more heavily to rural areas. Moreover, the investment in the direction of digitization will be conducive to the promotion of "creativity", which has the characteristics of non-competition and incremental payoffs [43], and will enable fiscal spending to bring more value to the development of rural areas than the spending itself, thus reducing the income gap between urban and rural areas. It is important to note here that the development of rural and urban areas is dynamic and that the policy is not a once-and-for-all solution. Even if the policy is positioned as a "rural-oriented" policy, it is impossible to conclude its actual effects or whether or not it will be unsatisfactory or even counterproductive, and it is only by presenting both logical and factual evidence that it can be convincing. From an industrial perspective, in particular, the creation of the digital countryside has changed people and tools—the two main factors

that impede the growth of industries in rural areas. When rural laborers become digitally literate enough to use digital "new farming tools" like cell phones, the derivativeness of this new factor of production will be enhanced [44]. As a result, there will constantly be a need for new businesses, industries, and transportation options. The regeneration of rural areas will also benefit from this internal drive. Secondly, the policy's implementation entails the release of economic signals and favorable measures for the digital countryside, such as tax and fee reductions, which create a favorable environment for investment in rural areas and extend invitations to profit-driven capital to station there in order to support the industry's upgrading and prosperity. From the perspective of employment, on the one hand, the development of industries will lead to the employment of rural residents and improve their consumption ability. A new round of consumption will lead to a new round of industrial development so that the economic cycle in rural areas is smooth, bringing more employment opportunities and improving the work's welfare and remuneration. On the other hand, given that the digital era has a "network effect" [35], which means more access to users means that the value of data will not only not be depleted but will also become more excellent, the cultivation of rural residents' digital literacy through digital village construction has given rural residents an endogenous development impetus, which has enhanced the development potential of rural labor and the opportunity for upward career mobility. The construction of the digital village has aided in the growth of industries, improved worker quality of employment, and decreased the income gap between urban and rural areas through the creation, matching, and multiplier effects. The urban–rural income gap is the difference in income between residents, but ultimately it is the difference between laborers.

Based on this, the two main research hypotheses of this paper are presented:

Hypothesis 1. *Digital village construction can reduce the urban–rural income gap.*

Hypothesis 2. *Digital village construction reduces the urban–rural income gap in the county by promoting changes in the county's industrial structure and increasing the proportion of secondary and tertiary industries.*

4. Materials and Methods

4.1. Econometric Models and Identification Strategy

4.1.1. Baseline Regression Model

An economic model is created to ascertain the urban–rural income difference in order to investigate the effects of digital village construction on that gap. We propose that the digital countryside index for a county is a measure of the degree of digital countryside building, and that the greater the index, the better and higher the degree of construction in the county. The urban–rural income gap is also affected by county-level characteristics, such as the level of county human capital, demographic structure, level of economic development, and level of urbanization, which are included as control variables. An ordinary least squares (OLS) approach is used to evaluate the average impact of digital village construction on the urban–rural income gap at the county level, with reference to the body of existing literature. The benchmark model of urban–rural income identified is expressed as:

$$URIG_i = \beta_0 + \beta_1 DVI_i + \beta_2 Z_i + \varepsilon_i \quad (1)$$

The subscript denotes the i county in the sample county, URIG means the County's urban–rural income gap, DVI represents the Digital Village Index, Z represents the county-level characteristic variables, ε is a randomized disturbance term, and β_0, β_1, and β_2 are the parameters to be estimated.

4.1.2. Model for Endogeneity Correction

As an exogenous policy impact, digital village construction has been implemented in all counties in China, which circumvents many problems for the scientific conduct of the

study; however, it should not be ignored that county data are difficult to obtain, with many missing data, and all samples containing missing values are excluded; however, the lack of economic and social data in a county usually reflects the differences in administrative and governance capacity, economic development level, or natural geography between the county and the sample counties with no missing values. However, the missing economic and social data of a county usually also reflect the difference between that county and the sample counties without missing values in terms of administrative governance capacity, economic development level, or natural geographic environment, so this study may have the problem of selective bias; in addition, the influencing factors of the urban–rural income gap are numerous and complex, so this study may have the problem of omitted variable bias. In order to address the endogeneity issue, this study uses a two-stage least squares (2SLS) model and chooses suitable instrumental variables. The model that is created is:

$$DVIv_i = \beta_0 + \beta_1 IV_i + \beta_2 Z_i + \varepsilon_i \quad (2)$$

$$URIG_i = \beta_0 + \beta_1 DVIv_i + \beta_2 Z_i + \varepsilon_i \quad (3)$$

IV_i is the ith instrumental variable, DVIvi represents the Digital Village Index, URIGi means the County's Urban–Rural Income Gap, Z_i represents the county-level characteristic variables, ε is a randomized disturbance term, and β_0, β_1, and β_2 are the parameters to be estimated.

4.1.3. Models for the Investigation of Mechanisms

The direction of the income gap between urban and rural areas is somewhat determined by changes in the industrial structure. By concentrating on whether the construction of digital villages alters the share of primary, secondary, and tertiary industries' value added in GDP, this study aims to ascertain whether changes in industrial structure are one of the ways that the development of digital villages impacts the income disparity between urban and rural areas. The explanatory variable in the benchmark regression is changed from the urban–rural income disparity to the industrial structure shift based on the body of existing literature. The resulting model is as follows:

$$INS_i = \beta_0 + \beta_1 DVI_i + \beta_2 Z_i + \varepsilon_i \quad (4)$$

INS_i is the industrial structure of the ith county, DVI_i represents the Digital Village Index, Z_i represents the county-level characteristic variables, ε is a randomized disturbance term, and β_0, β_1, and β_2 are the parameters to be estimated.

4.2. Variable Measure and Explanation

4.2.1. Core Independent Variable: Digital Village Construction

As a stand-in variable for digital village development, this study uses the county-level Digital Village Index (DVI), the 2020 Digital Rural Index released by Peking University's Institute of New Rural Development, and the Alibaba Research Institute's Digital Rural Index Database [45]. The Rural Digital Infrastructure Index, Rural Economy Digitization Index, Rural Governance Digitization Index, and Rural Life Digitization Index comprise the quality of index construction of the Digital Rural Index. These four first-level indicators are weighted at 27%, 40%, 14%, and 19%, respectively, and cover the meaning and extension of the digital countryside. Under it are 16 secondary and 33 specific indicators covering almost all aspects of digital village construction. These can more accurately depict the development of digital villages at the county level and satisfy this study's need for a certain amount of data. In terms of sample representativeness, the Digital Countryside Index covers 87% of China's county-level administrative units, excluding only the samples of counties where the proportion of agricultural GDP is less than 3% and where a high level of urbanization has been achieved, which meets the data breadth required for this study.

4.2.2. Dependent Variable: Urban–Rural Income Gap

The explanatory variable is the urban–rural income gap, which is measured by dividing the disposable income of urban residents by the disposable income of rural residents in each county: if the ratio of a county is 2, it means that the disposable income of urban residents in that county is twice as much as the disposable income of rural residents, which is a more intuitive approach and one of the most commonly used methods by scholars in China.

4.2.3. Control Variables

Other factors that could have a major impact on the income disparity between urban and rural areas are also controlled for in addition to the basic variables mentioned above. These variables focus on the county level, mainly in the following areas.

First, demographic characteristics, including urbanization rate (URBAN), aging rate (AGING), and education level (EDU) are included. Rural labor transfer to urban areas is beneficial to raising rural income levels under the constraint of declining returns to land scale [46], as evidenced by the increase in the pace of urbanization and the closing of the income gap between urban and rural areas. The diversity of the population across age groups will be mirrored in the pay scale. When the age structure of the population of a region changes, the income gap will also change [47]. Aging is one of the main demographic trends in China, and its impact on the urban–rural income gap needs attention. The average number of years of schooling at the county level is used to reflect the degree of education. Investment in human capital, such as education, is important for understanding income distribution.

Second, economic traits, such as the degree of industrial structure, fiscal expenditure (FISC), financial development (FINANC), and economic development (ECON) are considered. Academics have been concerned about the issue of "economic development level and income gap" for a long time and have developed two opposing main points of view, the "trickle-down effect" and the "Matthew effect". The degree of economic progress is shown by the GDP logarithm, and the main reason for taking the logarithm is to make the data more generally distributed to increase the accuracy of the regression results. Because the primary industry practitioners are often rural residents, if the proportion of the secondary industry (IND_SEC) and the tertiary industry (IND_TER) development in the overall economy is significant, the rural residents engaged in the primary sector have a smaller overall income. Income distribution is a crucial aspect of public finance, and the focus of budgetary expenditures—"equity" or "efficiency"—determines the direction of their influence on the income difference between urban and rural areas. The focus of the use of funds, as indicated by the year-end financial loan balance as a percentage of GDP, also influences the level of financial development, which is a reflection of the region's economic dynamism and the urban–rural income difference.

Third, the characteristics of resource endowment, including the level of transportation development (TRANSP) and whether it has been a poor county (POOR), are assessed. Improving transportation facilities is conducive to rural labor mobility and promotes urban–rural integration [48]. The length of time since high-speed rail opening is used to indicate the level of transportation development, i.e., the length from the year of station opening to 2020. At the end of 2020, all of China's impoverished countries will have been removed from poverty, and poverty eradication and removal is not the end point but a new starting point. Compared with the counties that have never been poor, the counties that have just been lifted out of poverty have less initial resource endowment and their endogenous development capacity is weaker.

4.2.4. Instrumental Variables

This study chooses "topographic relief" as an instrumental variable for each county based on the body of available knowledge [31]. On the one hand, the government will prioritize the construction of digital villages in areas with low degrees of topographic

relief because a high degree of relief will make it more difficult to build and maintain digital infrastructure in the creation of digital villages, leading to higher management and maintenance costs; high degrees of topographic relief may also block the signal, resulting in the consequence of poor local signals, which affects the effectiveness of the construction of digital villages and meets the relevance condition. On the other hand, the degree of topographic relief belongs to geographic features, and the perturbation term affecting the urban–rural income gap tends to be economic features, with which the degree of topographic relief has little relationship, and it is difficult to find the correlation law between the two in practice, which satisfies the condition of exogeneity. The empirical findings that follow demonstrate that the instrumental variables included in this investigation pass the correlation and exogeneity tests.

4.3. Data Sources

Counties (cities and districts), as "front-line commanders", hold the main economic power in China [49]. Examining the success of building local digital villages at the county (city and district) level is more suitable. This study's data are all at the county level.

The first part is the 2020 digital village construction dataset, which acts as the core independent variable. It comes from the 2020 Digital Rural Index released by the Institute of New Rural Development of Peking University and the Digital Rural Index Database of County Areas of Ali Research Institute, which consists of four dimensions, namely, the rural digital infrastructure index, the rural economic digitization index, the rural governance digitization index and the rural life digitization index. It is built up by four dimensions, the rural digital infrastructure index, rural economic digitization index, rural governance digitization index, and rural life digitization index, which can vividly reflect the connotation and level of digital construction with high overall quality, and it is one of the most authoritative datasets for studying digital countryside issues in China. The index database only published two years of indexes, in 2018 and 2020, but the indexes of these two years are not comparable, so the latest index for the year 2020 is selected for this study. Furthermore, the digital village strategy's blueprint paper was formally launched in 2019, and given the actual delay in the appearance of policy effects and the accessibility of county data, it makes sense to utilize 2020 data.

The second set of data comes from the China County Statistical Yearbook 2021 (County and City Volume) and pertains to the income discrepancy between urban and rural areas. The China Bureau of Statistics has officially released this data collection, which includes details on the general economic conditions and state of almost 2000 county units nationwide in 2020.

Third, the data of control variables are included. Variables related to demographic characteristics, including urbanization rate, aging rate, and education level, are obtained from the "2020 China Population Census County Data", i.e., the 7th National Population Census County Data, which focuses more on the resident population and avoids the bias that may be caused by the current situation of separating people from households in China. Additionally, the China County Statistical Yearbook 2021 (County and City Volume) contains the economic development data. In addition, the number of years since high-speed rail opening, which indicates the level of transportation, is obtained by compiling public government information and Gaode Maps. Whether a county is a poverty-free county is determined based on public information on government websites to indicate endowment.

After combining these parts of the data, the samples with missing key variables are deleted, outliers are excluded, and finally, the data of 865 counties are used as the research object for empirical analysis. Figure 2 shows the distribution of the 865 sample counties; they are marked as green in the map of Chinese counties, and other uncolored areas are not in the sample of this study.

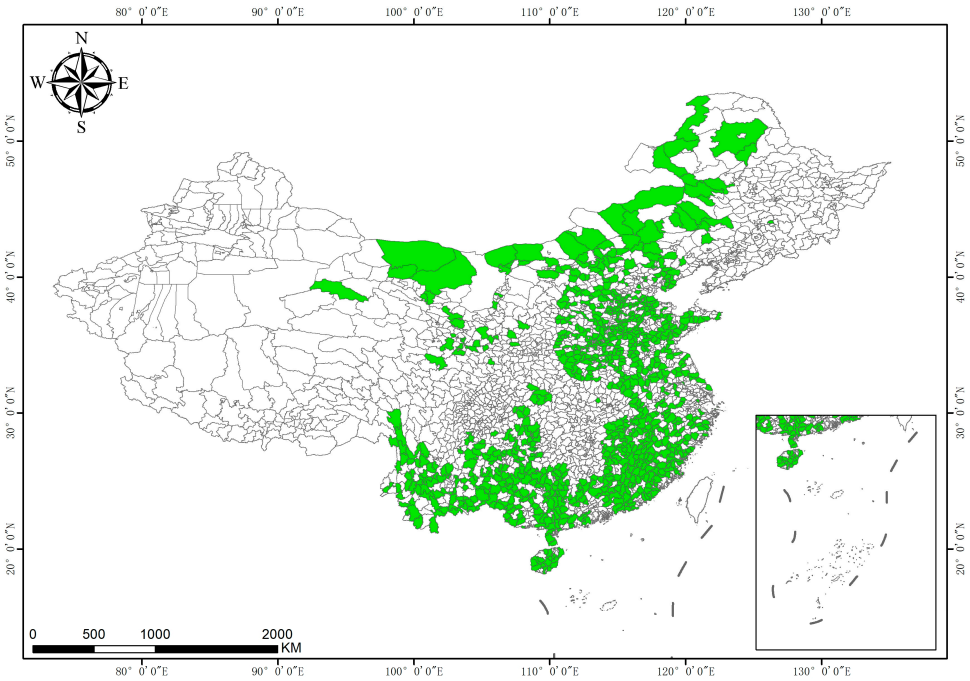


Figure 2. Research area.

4.4. Descriptive Statistics

Table 1 shows the descriptive statistics of the variables. The average disparity between the disposable incomes of urban and rural people in the sample counties is 2.2048, meaning that urban residents have an average disposable income 2.2048 times higher than rural residents. The general situation across China is roughly the same at 2.5. The average level of education in the counties in the sample is 8.6 years, and the overall situation in China is 9.9 years. The level of urbanization in the sample is 48%, and 63% for China overall. The proportion of the population aged 60 and over is 19.76% for the sample and 18.7% for China as a whole. This shows that, in general, the sample's situation reflects the overall situation in China and the sample values and the overall values are relatively close to each other. However, because the research question is the digitalization level of rural areas, and in some economically developed and highly urbanized counties in China there is no rural population or only a very small rural population, these developed counties are not the object of our concern; they are not in the sample. As such, the urban–rural income disparity, the education level, and the urbanization level of the sample are lower than the overall value, while the aging level is higher than the overall value. This also reminds us that the exodus of young adults from rural areas has led to a rise in the share of the elderly.

Table 1. Descriptive statistics of major variables.

Variable	Description	Unit	Type	Obs	Mean	Std. Dev.
URIG	Ratio of disposable income of urban and rural residents; disposable income of urban residents/disposable income of rural residents at the county level.	Multiple	Continuous	865	2.2048	0.5046
DRI	Digital village index; calculated after an assessment of the level of digitization of the countryside in each county and provided directly by the data source, it is a score reflecting the level of digitization.	Score	Continuous	865	60.3739	11.6105

Table 1. *Cont.*

Variable	Description	Unit	Type	Obs	Mean	Std. Dev.
URBAN	Proportion of urban population in total population; (population of towns/population of county) × 100%.	%	Continuous	865	48.41	0.1207
AGING	Proportion of population aged 60 and over in total population; (number of persons aged 60/total population) × 100%.	%	Continuous	865	19.76	0.0416
EDU	Regional average years of schooling; obtained by asking how many years of schooling, summing the answers for all individual samples in the county and dividing by the total number of people in the county, provided directly by the data source.	Year	Continuous	865	8.6068	0.6743
ECON	Logarithm of GDP per capita; in (total GDP/total county population).	-	Continuous	865	10.8616	1.1247
IND_SEC	Value added of the secondary sector as a proportion of GDP; (value added of secondary industry/GDP) × 100%.	%	Continuous	865	34.64	0.1287
IND_TER	Value added of tertiary sector as a proportion of GDP; (value added of tertiary industry/GDP) × 100%.	%	Continuous	865	46.37	0.0889
FISC	General public budget expenditure as a proportion of GDP; (county's general public budget expenditure/GDP) × 100%.	%	Continuous	865	28.12	0.1764
FINANC	Financial loan balance as a proportion of GDP at the end of the year; (financial loan balance at end of year/GDP) × 100%.	%	Continuous	865	89.44	0.4151
TRANSP	Length of years the high-speed railroad has been in operation; 2020 minus the year the county site opened.	Year	Continuous	865	1.2439	2.6765
POOR	Counties lifted out of poverty = 1; counties never been in poverty = 0.	-	Dummy	865	0.3584	0.4798

5. Empirical Results and Analysis

5.1. Main Results

The empirical findings of the OLS model test of the effect of developing digital villages on the income gap between urban and rural areas are presented in Table 2. To be more precise, the dependent variable is the income gap between urban and rural areas, while the proxy variable for the building of digital villages is the digital village index. The computed coefficients show how building digital villages often affects the income disparity between urban and rural areas.

Column (1) does not contain control variables and column (2) contains all control variables. The results in column (2) show that digital village construction is statistically significant at the 1% level and has a negative coefficient, i.e., all else being equal, digital village construction reduces the urban–rural income gap. The marginal effect shows that, all other things being equal, for every one-unit increase in the degree of digital countryside construction (digital countryside index), the urban–rural income gap between counties (cities and districts) will be reduced by 1.17% on average; this indicates that with the continuous increase in the degree of digitalization construction, the urban–rural income gap will ultimately be obliterated.

This experimental finding supports Hypothesis 1, which states that the development of digital villages can close the income gap between urban and rural areas. Based on the theoretical analysis presented in the previous section, it is possible that the construction of digital villages alters the industrial structure of counties (cities and districts), induces the flow and reallocation of factors, and creates opportunities for the development of rural areas and the improvement of rural residents' employment levels. Additionally, by

increasing the incomes of rural residents, the construction of digital villages reduces the urban–rural income gap. The next section will put the mechanisms behind the shift in industrial structure to the test once more.

Table 2. Regression results of the impact of digital rural construction on urban–rural income gap.

Variable Name	Explained Variable: URIG (Urban–Rural Income Gap)	
	(1)	(2)
DRI	−0.0200 *** (0.0014)	−0.0117 *** (0.0016)
URBAN		−0.4593 *** (0.1501)
AGING		−0.4227 (0.2932)
EDU		−0.0405 (0.0257)
ECON		−0.0399 *** (0.0127)
IND_SEC		1.3874 *** (0.1802)
IND_TER		1.1224 *** (0.2457)
FISC		0.2099 (0.1527)
FINANC		0.0905 (0.0689)
TRANSP		0.0062 * (0.0037)
POOR		0.5387 *** (0.0345)
Constant	3.4124 *** (0.0908)	2.6549 *** (0.2840)
Observations	865	865
R-squared	0.2118	0.5455

Note: Robust standard errors are in parentheses; *** $p < 0.01$, * $p < 0.1$.

5.2. Endogeneity Analysis

In this section, instrumental variables are used to mitigate the problem of possible omitted variable bias and the possible problem of selective bias. Topographic relief is used as an instrumental variable for digital village construction. Table 3 shows the estimation results of the 2SLS regression. The regression results are reported. The selected instrumental variables appear to meet the relevance criteria in the first stage test, as the F-value is larger than 10, implying that there is no weak instrumental variable issue; the findings of the second stage of estimation indicate that, when all other factors are held constant, the estimated coefficient of digital countryside construction is significant at the 1% level and negative, meaning that it can considerably close the income gap between urban and rural areas. The findings of the baseline regression and the instrumental variable estimation are in agreement.

Table 3. Regression results of the impact of digital village construction on urban–rural income gap.

Variable Name	Explained Variable: URIG (Urban–Rural Income Gap)	
	Coefficient	**Standard Error**
DRI	−0.0283 ***	0.0041
Control Variables	Control	
Wald χ^2	758.69	
First stage coefficient	−5.68326 ***	
F-value	85.41	

Note: *** $p < 0.01$.

5.3. Robustness Tests

The robustness test results of changing the explanatory factors are given in this section. The digital countryside index has been replaced by the rural digital infrastructure index, rural economic digitalization index, rural governance digitalization index, and rural life digitalization index, according to the 2020 Digital Countryside Index published by the County Digital Countryside Index Database. Table 4 displays the findings of the regress of the four sub-indexes using the OLS model, which not only offers a robustness test but also looks at the impact of various construction parameters of the digital countryside, offering a helpful guide for practice.

Table 4. Robustness regressions with replacement as sub-indicator.

Variable Name	Explained Variable: URIG (Urban–Rural Income Gap)			
	(1)	**(2)**	**(3)**	**(4)**
Rural Digital Infrastructure	−0.0082 *** (0.0018)			
Rural Economic Digitalization		−0.0082 *** (0.0012)		
Rural Governance Digitalization			−0.0034 *** (0.0007)	
Rural Life Digitalization				−0.0046 *** (0.0008)
Control Variables	Control	Control	Control	Control
Observations	865	865	865	865
R-squared	0.5202	0.5330	0.5205	0.5319

Note: Robust standard errors are in parentheses; *** $p < 0.01$.

The results show that the four construction dimensions of rural digital infrastructure, rural economic digitization, rural governance digitization, and rural life digitization are all significant at the 1% statistical level with negative coefficients, i.e., the four construction dimensions of digital countryside have effectively reduced the urban–rural income gap. The marginal effect shows that, under the premise of other conditions remaining unchanged, for every one-unit increase in the degree of rural digital infrastructure construction, the urban–rural income gap will be narrowed by 0.82% on average; similarly, the urban–rural income gap-narrowing effects of rural economic digitization, rural governance digitization, and rural life digitization are 0.82%, 0.34%, and 0.46%, respectively. The construction from the dimensions of rural digital infrastructure and rural economic digitization has the most significant effect on reducing the urban–rural income gap, and rural governance digitization has the most miniature reduction effect. This suggests that, only from the perspective of 2020, measures that are most directly related to raising income, such as completing rural digital hardware facilities and creating a digital economic environment, will have the best effect on narrowing the urban–rural income gap, while measures that rely on the formation of rural residents' digital habits, such as changing the way of rural

governance and upgrading the level of digitalization of rural life, will have less of an effect in the short term.

5.4. Mechanism Tests

This section of the content adopts the method of replacing the explanatory variable as industrial structure and uses the OLS model to examine the impact of the construction of the digital village on the change of industrial structure in order to test Hypothesis 2, which states that the change in the county's industrial structure is the mechanism by which the construction of the digital village affects the urban–rural income gap. Table 5 presents the findings. After taking into account all of the control variables, the table's columns (1) through (3) look at how the variable of digital countryside construction affects the value-added shares of the primary, secondary, and tertiary industries in GDP.

Table 5. The impact of digital village construction on changes in industrial structure.

Variable Name	Explained Variable: Changes in Industrial Structure		
	(1)	(2)	(3)
DRI	−0.0030 ***	0.0020 ***	0.0010 ***
	(0.0003)	(0.0004)	(0.0003)
Control Variables	Control	Control	Control
Observations	865	865	865
R-squared	0.3449	0.3551	0.2731

Note: Robust standard errors are in parentheses; *** $p < 0.01$.

These results show that the effects of digital village construction on changes in industrial structure are all significant at the 1% statistical level, i.e., digital village construction changes industrial institutions in a causal sense. In particular, the primary industry's coefficient is negative while the secondary and tertiary industries' coefficients are positive. This indicates that while the building of digital rural areas increases the GDP value added by secondary and tertiary sectors, it lowers the GDP value contributed by the primary industry. Accordingly, integrating digital technology into every industry will boost output value and productivity while also raising GDP as a whole. Even if the primary industry's output value increases, its added value share of the GDP may decrease because of the modest capital volume of this sector compared to the huge capital volumes of the secondary and tertiary sectors. Additionally, based on observable short-term data, the secondary industry can more directly benefit from the new infrastructures and integrated resources brought about by the development of digital villages. These resources can be quickly and effectively converted into the industry's added value, with a proportion of GDP that is marginally higher than that of the tertiary industry's added value. Changes in the structure of secondary and tertiary industries affect the income gap between urban and rural areas. This conclusion can be seen from Lewis's theory of dual economic structure, which shows that the non-agricultural transfer of surplus agricultural labor can contribute to the gradual disappearance of the dual structure; the digital village construction also changes the industrial structure in the sense of cause and effect; thus, changes in the industrial structure are an essential mechanism to prove that the digital village construction affects the income gap between urban and rural areas.

In addition, considering the standard way of realizing digital rural construction—agricultural products' e-commerce with goods—e-commerce is included in the statistics of the tertiary industry, but the presentation of the final form of the farming products is embedded in the processing of farm products attributed to the secondary sector and the production of agricultural products attributed to the primary industry. Most of the results of the construction of the digital village are essentially the product of the parallel integration of the industry. Among them, the value added by the tertiary sector accounts for the most significant proportion of GDP, indicating that profits are concentrated in the back-end to

enhance the disposable income of rural residents and narrow the income gap between urban and rural areas; on the one hand, this should enable rural residents to participate more in the back-end of agricultural products; on the other hand, this should enhance the level of digitization of the front- and mid-end, and gain profits by improving efficiency.

5.5. Heterogeneity Tests

5.5.1. Regional Heterogeneity

Given the size of China and the wide variations in resource endowment across its territory, more research is required to determine whether the development of digital villages has varying effects based on endowment conditions. To determine whether there are variations in the effects of digital village construction among regions with different resource endowments, the sample counties in this study are divided into three regions: western, central, and eastern. The results are displayed in Table 6. The results show that the regression of digital village construction in the western region is not significant, the regression in the central region is substantial at the statistical level of 1% with a negative coefficient, and the regression in the eastern region is significant at the statistical level of 5% with a negative coefficient. This suggests that digital rural construction can widen the urban–rural income gap for counties (cities and districts) in the western region. In contrast, digital rural construction can narrow the urban–rural income gap for counties (cities and districts) in the central and eastern areas. This may imply that the effective implementation of digital village construction needs to rely on certain primary conditions, as the so-called clever woman cannot cook without rice. On the one hand, the natural endowment conditions of high mountains and high temperatures in the western region are not conducive to the construction of digital infrastructure, and regional endowment differences and the absence of key elements will prevent the effectiveness of digital village construction from reaching a significant level; on the other hand, small farmers in the western region do not have enough capacity to participate in the digital market for agricultural products, and it is not easy to rely solely on market mechanisms to complete the docking with the digital market.

Table 6. The impact of digital village construction on changes in industrial structure.

Variable Name	Explained Variable: URIG (Urban–Rural Income Gap)		
	Western Region	**Central Region**	**Eastern Region**
DRI	−0.0011	−0.0151 ***	−0.0045 **
	(0.0036)	(0.0039)	(0.0019)
Control Variables	Control	Control	Control
Observations	276	253	336
R-squared	0.4775	0.6207	0.4669

Note: Robust standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$.

Data from China's National Bureau of Statistics show that the eastern and western parts of China carry 73.05% of the country's population and generate 78.91% of the country's GDP with 40.75% of the country's land area, while the western part of the country carries 26.95% of the country's population and generates 21.09% of the country's GDP with 59.25% of the country's land area [50]. It is possible find that the development of the western part of the country is not conducive to both population aggregation and economic development, and the conclusion of the article and China's actual situation are consistent.

5.5.2. Poverty Heterogeneity

China has previously designated 832 national-level poverty-stricken counties, and with the help of precise poverty alleviation and other policies, these counties have been gradually lifted out of poverty since 2016 and were lifted out of poverty by 2020. In this section, based on information from a government website, the counties that used to be poor and are now out of poverty are defined as poverty alleviation counties and assigned a

value of 1, and the counties that have never been poor are defined as non-poor counties and assigned a value of 0. The dichotomous variables obtained are then used as moderating variables, and the interaction terms with the digital countryside construction are put into the OLS model for the regression. The fact that a county = 1 implies that the initial endowment and endogenous development capacity of the county are different from that of a non-poor county, specifically being poorer, and it also implies that the county enjoys pro-poor transitional tilting policies, so there may be a difference in the two types of counties' response to digital village construction, and the exploration of the effectiveness of digital village construction in the poverty alleviation counties is also an answer to the question of whether or not the policy of digital village construction has a poverty-benefiting nature. This strategy mirrors the original goal of building digital villages—bridging the digital divide and fostering shared prosperity—by concentrating on counties with comparatively weaker development capacities. Table 7 displays the results of the regression.

Table 7. Test of poverty benefit of digital rural construction.

Variable Name	Explained Variable: URIG (Urban–Rural Income Gap)	
	Coefficient	**Standard Error**
POOR×DRI	−0.0106 ***	0.0024
DRI	−0.0080 ***	0.0018
POOR	1.1508 ***	0.1533
Control Variables	Control	
Observations	865	
R-squared	0.5557	

Note: The sample involves 310 counties that have been lifted out of poverty and 555 counties that have never been poor; *** $p < 0.01$.

These results show that, all other things being equal, digital village construction plays a more significant role in narrowing the urban–rural income gap in poverty-stricken counties than in never-poverty-stricken counties, i.e., digital village construction has a pro-poor nature. This could be connected to the state's effort to broaden and combine the outcomes of eliminating poverty, where building digital villages and policy favoring work in tandem. Since the initial endowment of poverty-stricken counties is at a disadvantage, their development capacity is weaker. Since their total capital volume is small, the incremental increase in rural residents' disposable income brought about by the development of the digital countryside as a whole will increase proportionately. This will be reflected in the decline in the indicator ratio of rural to urban residents' disposable income. This result is consistent with the reality in China. Taking Guizhou Province in China as an example, in 2012, Guizhou was the province with the largest number of poor people in China, with 9.23 million poor people. With the cooperation of digital village construction and poverty alleviation policies, Guizhou has been at the forefront of the country's economic growth rate and the growth rate of the digital economy many times in the past 10 years and has become China's first comprehensive pilot zone for big data. Guizhou's Pu'an County, a typical poverty eradication county, has now been transformed into a "Hundred Leaves No. 1" tea planting base, where equipment has been implemented to notify temperature, humidity, and soil testing data, changing traditional production methods, helping farmers improve productivity and income, and helping to narrow the income gap between urban and rural areas in the region [51].

6. Discussion

The study conducted for this article on the impact of digital village building on the urban–rural income gap reveals that encouraging the development of digital villages has a significant influence on reducing the difference between urban and rural incomes, fostering urban–rural equity and fostering common prosperity. Many academics have confirmed that digital technology can support regional economic development. Findings regarding

the impact of digital technology on the income gap between urban and rural areas also demonstrate that while some groups can benefit from digital technology, others cannot. These groups include those who are excluded from digital technology due to having low human capital or no capacity to learn how to use it, as well as those who have no need for it. Zhang [52]; Yin and Sun [32] both agree that the policies implemented by the digital village construction for rural areas help farmers alleviate digital exclusion, obtain digital dividends, and improve their incomes, which is consistent with the conclusions of this paper. The difference is that these two articles focus more on farmers in ecologically fragile ethnic areas and main forestry production areas, while the research object of this paper is more generalized. An article that differs from the conclusion of this paper is the study of Li and Li: the article starts from the perspective of skill premium and argues that the impact of digital rural construction on the urban–rural income gap is produces an inverted U-shaped trend [33], and the perspective is very innovative and contributes to the discussion; however, the article confuses digital rural construction with the generalized digital economy in the theoretical analysis, ignoring the specificity of the nature of digital rural construction in the region where it is implemented, i.e., rural areas; in addition, in the empirical regression, the article used 2019 and 2020 data, and in terms of longitudinal time, the digital countryside index of the same individual in these two years will not be too different. As such, horizontal inter-individual comparisons are more useful, but the article ignored the relevant variables of regional demographics, human capital, urbanization rate, and other characteristics that have a great impact on the urban–rural income gap. There is a problem of omitted variable bias, and the inverted U-shape may be caused by one of the important variables.

The findings on industrial structure change as a mechanism variable of digital village construction affecting the urban–rural income gap provide a useful reference for the next step of promoting digital village construction and common wealth in China. This is consistent with the findings of Zhao and Zhao [53], which affirm that digital village construction is conducive to the development of secondary and tertiary industries in the countryside and, furthermore, the premium brought about by the increase in the level of industrialization is conducive to the increase in farmers' incomes and the narrowing of the urban–rural income gap. It is worth noting that the situation leading to the decline of the primary industry's share of GDP is related to the small volume of capital in the primary industry, which does not shake the status of the primary industry as a basic industry.

The results of this study on the differences in the construction effects of the four dimensions of digital village construction show that, if the reduction of the urban–rural income gap is the goal, the construction of digital infrastructure and the digitization of the economy are the most important aspects to be carried out. In addition to the different construction effects brought about by the construction methods, the basic conditions of the construction sites will also affect the construction effects. The regression of the sample divided into east, central, and west regions found that the endowment conditions in the west have not played a significant role in narrowing the urban–rural income gap in via digital village construction, which means that the good operation of the digital village construction needs certain supporting conditions, and the market mechanism alone cannot activate the effects of digital village construction. After the sample is divided into poverty-stricken counties and non-poor counties and then regressed as an interaction term between the moderating variable and the digital village construction, it is found that digital village construction has a better effect on narrowing the urban–rural income gap in poverty-stricken counties with poorer initial endowments, which is related to China's transitional poverty alleviation measures in these poverty-stricken counties, which include transfusions of funds and supporting measures such as providing jobs and nationwide recruitment of residents, which are all related to China's poverty alleviation measures. These measures, which include supporting financial subsidies, supporting jobs for residents, and nationwide selection of outstanding individuals to head local governments, reaffirm the effectiveness

of the policy of favoring specific regions and the importance of the transitional policy in upgrading the basic conditions in the poverty-stricken counties.

7. Conclusions

7.1. Conclusions of the Research

This study analyzes how the construction of digital villages affects the urban–rural income gap, puts forward hypotheses on the direction and mechanism of influence through theoretical analysis, and validates them using an OLS model with data from 865 counties in China in 2020. The results are as follows:

(1) The construction of digital villages can significantly reduce the urban–rural income gap in counties, and the results are still negatively significant after correcting for endogeneity by constructing a 2SLS model with the instrumental variable method selected. Hypothesis 1 is verified;
(2) In the process of promoting digital village construction to reduce the urban–rural income gap, the change of industrial structure is an important mechanism variable, and the more the proportion of secondary and tertiary industries increases, the smaller the urban–rural income gap becomes. Hypothesis 2 is verified;
(3) When examining how well the four construction characteristics of digital village construction contribute to closing the income gap between urban and rural areas, the findings are still quite significant. The digital infrastructure of the countryside and the digitization of the rural economy, on the other hand, play the largest and second largest roles, respectively, while the digitization of rural governance and rural livelihoods play the smallest roles; the coefficients vary;
(4) A test of regional heterogeneity in the rural–urban income-shrinking effect of digital village construction shows that the policy effect is significant in the eastern-central part of the country and not in the west;
(5) A test of the heterogeneity of digital village construction in poverty alleviation counties shows that the policy reduces the urban–rural income gap more in poverty alleviation counties than in non-poor counties.

7.2. Policy Recommendations Based on Research Findings

(1) The Chinese Government should continue to promote the construction of digital villages. It should play the role of an active government, accelerate the bridging of the digital access gap, especially in terms of digital infrastructure construction and digital economization, guarantee the quantity and quality of rural network access, and build a digital platform to improve the efficiency of agricultural production;
(2) The government should also grasp the opportunity of digital village construction, promote the upgrading of the county's industrial structure and the integrated development of primary, secondary, and tertiary industries, empower the production and processing of agricultural products with digital technology to improve quality and efficiency, activate the advantages of agricultural products supply and marketing in rural areas with digital platforms, and increase the income of rural residents;
(3) The government should play a coordinating role in alleviating the regional differences in the construction of digital villages and focus on the promotion of policies, tilting support to the western region, and summarizing and publicizing the results of cases with outstanding results in the central and eastern parts of the country, so as to give play to the demonstration effect;
(4) Digital village construction in poverty-stricken counties should maintain its strength, extend its depth, and broaden its scope; when supporting poverty-stricken counties, attention should be paid to fostering the digital literacy of local residents, and digital village construction should be regarded as a powerful means to consolidate and expand the results of poverty alleviation and the effective connection between poverty alleviation and rural revitalization in the new period, so as to ensure that poverty alleviation counties can pass through the "transition period" smoothly.

7.3. Challenges and Coping Strategies

First, a sustainable approach to digital village building should be found. The construction of digital villages is a policy to promote equity in which the Chinese Government bears a great responsibility, which means that it requires a large amount of long-term government funding, and relying on government funding alone will threaten the sustainability of the policy. Learning from the successful experiences of developed countries, the government should take the lead in promoting competition among digital service providers, providing rural residents with digital services at a good quality and low price, and providing a sustainable mechanism to ensure the sustainability of the policy.

Second, a sustainable and comprehensive evaluation system for the effectiveness of digital village construction should be established. If the economy is the only assessment goal, local governments may neglect the construction of digital village governance and digital life, which are slower to play a role in the economy, but these constructions are about concepts and habits, which are conducive to the sustainable construction of rural residents' digital literacy, and are necessary to enhance the human capital of the region; in addition, with the deepening of urbanization and aging, the young and the old are going out to work and the countryside is full of elderly people, so digital governance and digital service providers should establish a sustainable and comprehensive evaluation system. In addition, as urbanization and aging deepen, young adults go out to work, and more elderly people live in the countryside, digital governance and digital living are more related to the quality of life of the elderly.

7.4. The Research Limitations and Future Research Directions

The first limitation is the length of the data period, as this study only uses cross-sectional data from 2020; as new circumstances arise in the ongoing promotion of digital villages, cross-sectional data is unable to capture the dynamic shifts that occur in the policy-promotion process. To infer that the impact of digital village construction on the urban–rural income gap may be narrowing or similar to an inverted U-shape, researchers need long-term tracking data for further verification. To investigate the efficacy of digital village development in the context of common wealth, a more rigorous and scientific approach would be to create panel data and track the effects of follow-up policies.

The second limitation is the research level, as this paper observes the urban–rural income gap from the county level and lacks observations and tests from the micro-farmer household level. The higher the level of the study, the easier it is to blur the characteristics, and assessing the effectiveness of the digital village construction from the micro level of farmers and identifying more clearly the improvement of farmers' welfare and relative status of the policy is the next step that needs to be analyzed in depth.

The third limitation is the research perspective, as this paper evaluates the effectiveness of digital village construction from the perspective of the urban–rural income gap. In essence, the role of digital village construction is multifaceted, the economy is only one part of it, and other meaningful aspects such as the improvement of governance efficiency and ecological environment in the countryside are ignored in this study. The results derived in this paper for the four construction dimensions of the Digital Infrastructure Index, Rural Economy Digitization Index, Rural Governance Digitization Index, and Rural Life Digitization Index are only beneficial to counties that want to rapidly improve their economy. Improvements in governance concepts and lifestyles may be more subtle and related to sustainable development, and this aspect needs to be further explored.

Fourthly, the discussion on the threshold for digital village construction to play a role in narrowing the income gap between urban and rural areas needs to be supplemented. There is indeed a gap between western China and central and eastern China, but the extent to which the western part of the country needs to improve its infrastructure in order to reach the threshold to get on the "express train" of the digital economy is an issue worth exploring. It would also be interesting to look at this question in the context of poverty

reduction counties and to explore how much poverty reduction policies can contribute to reaching the threshold in these counties.

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