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Research on the Impact Mechanism of the Digital Divide on Urban-Rural Coordinated Development in Hainan

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Abstract:
With the steady advancement of the Hainan Free Trade Port, eliminating the digital divide, removing data barriers, and building a smart Free Trade Port have become focal points of attention. Currently, the rapid development of digital technology is revealing issues of the urban-rural digital divide in the process of constructing Smart Hainan. This paper begins by examining the current state of the digital divide between urban and rural areas in Hainan, analyzing the factors influencing coordinated urban-rural development, and explaining the mechanisms by which the digital divide impacts this development. It proposes strategies for narrowing the digital divide and promoting coordinated urban-rural development. Whether at the government level or in the market and technological spheres, this research provides theoretical significance and practical value for scientifically assessing the impact of the digital divide and advancing urban-rural integration in Hainan, offering relevant policy recommendations.

Keywords:
Urban-rural digital divide; Hainan; impact mechanism; coordinated development

1 Introduction

With the rapid development of big data, blockchain, cloud technology, and artificial intelligence, digitalization has become a crucial driving force for economic and social progress. The process of digitalization, its development level, and application scenarios are critical factors in determining the development gap between urban and rural areas. However, the presence of the urban-rural digital divide significantly impacts coordinated urban-rural development. Faced with the widening gap between urban and rural areas, narrowing this digital divide and promoting urban-rural integration have become increasingly urgent and necessary. The digital divide is not merely a technological gap but also a disparity in the levels of urban and rural development and regional economic imbalances. This disparity has widened the development directions and speeds between cities and rural areas, exacerbating their developmental imbalances. Hainan is one of the provinces where the issue of the urban-rural digital divide is particularly pronounced. Compared to provinces with well-developed digital economies, Hainan shows significant gaps in digital services between urban and rural areas and between different groups, both in terms of computational network integration capabilities and the fusion of cloud, network, and digital intelligence. As an important economic special zone and tourist destination, ad-

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dressing the urban-rural digital divide in Hainan is critical for promoting the development of the Hainan Free Trade Port.

2 Literature Review

The issue of the urban-rural digital divide has garnered widespread attention and research both domestically and internationally. International studies suggest that the existence of a digital divide exacerbates social, economic, and cultural disparities between urban and rural areas, hindering the sustainable development of rural regions. Similarly, numerous domestic studies indicate that the urban-rural digital divide has become a significant constraint on coordinated urban-rural development, impeding the goals of integrated urban-rural development and the achievement of a moderately prosperous society.

However, current research on the urban-rural digital divide, both domestically and internationally, is predominantly qualitative or descriptive in nature, lacking systematic and in-depth analysis. Particularly, there is a scarcity of studies exploring the mechanisms by which the digital divide affects coordinated urban-rural development. Moreover, existing research often focuses solely on specific urban or rural areas without considering the differences in the digital divide between various regions and different types of cities and rural areas. Consequently, devising concrete policies and measures to address the impact of the urban-rural digital divide remains a challenging task.

3 Current Status and Issues of the Urban-Rural Digital Divide in Hainan

3.1 High Fiber Optic Coverage but Low Digital Technology Adoption in Rural Areas

In modern society, digital technology has become an indispensable part of daily life. However, the extent of digital technology adoption remains low, affecting the enhancement of digital literacy in rural areas. According to the 50th Statistical Report on Internet Development in China, as of June 2022, the rural internet user base in China reached 293 million, with an internet penetration rate of 58.8%, compared to 82.9% in urban areas—a gap of 24.1 percentage points, indicating a significant urban-rural digital divide. Data shows that 100% of administrative villages in Hainan have fiber optic broadband coverage, and 99.51% of natural villages with over 20 households are covered. However, the extent of digital technology adoption among villagers is low. Surveys reveal that 87.36% of rural residents aged 60 and above in Hainan do not use smartphones, indicating a substantial portion of the rural population has limited digital skills.

The growing importance of digital technology in modern society necessitates its widespread adoption. Firstly, the adoption of digital technology directly impacts people's production and living standards. In the mobile internet era, mobile devices (such as smartphones, tablets, smart TVs, and wearable devices) play a crucial role in daily life, from accessing information, reading news, shopping, to traveling. The usage of these mobile devices is closely tied to the level of digital technology adoption. However, a significant portion of rural residents still lacks the knowledge to use these devices effectively, preventing them from leveraging digital technology in their daily lives and benefiting from its convenience. Secondly, the adoption of digital technology is foundational to the development of the digital and information economy. As the transformation

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and upgrading of the digital economy accelerate, digital technology has become a key driver of endogenous growth. The development of the digital and information economy can better support rural revitalization, promote rural economic development, and increase farmers' income. Thus, the low adoption rate of digital technology and the limited digital literacy among rural residents in Hainan are factors contributing to the urban-rural digital divide.

3.2 Low Education Levels in Rural Hainan

The 7th Population Census Bulletin of Hainan Province, released on May 13, 2021, shows a total population of 10,081,232 across 19 cities and counties in the province. Of this population, 1,403,194 have received higher education (college and above), 1,568,761 have completed high school (including vocational school), 4,050,000 have completed middle school, and 1,986,102 have completed primary school. The illiterate population (those aged 15 and above who are unable to read) numbers 327,406. This means that the population with middle school education or lower (including illiteracy) totals 6,363,508, accounting for 63.12% of the province's population. Additionally, the average years of schooling for the working-age population in Hainan was 11.1 years in 2022. Compared to the rapid evolution of new technologies and processes, the labor force with middle school education or lower struggles to meet the skill, knowledge, and ability requirements of digital technology.

Research indicates that a significant portion of the labor force in rural Hainan has a low education level, with many migrant workers and agricultural workers lacking relevant knowledge and skills, and unable to grasp digital technology applications. Compared to urban populations, rural populations in Hainan generally have lower education levels, mainly engaging in traditional agricultural production and working as casual laborers in cities. This educational disparity means rural workers face substantial barriers in mastering and applying digital technology, limiting their capacity for digital production and operation. This, in turn, affects the dissemination, promotion, and application of digital technology in agricultural production, posing challenges to its widespread adoption and application.

3.3 Underdeveloped Rural E-commerce Ecosystem

The rural e-commerce ecosystem, as a digital commerce system in rural areas, encompasses the entire industry and value chain of agricultural production, processing, sorting, distribution, storage, transportation, and sales. Building a rural e-commerce ecosystem helps promote rural economic development and increase farmers' incomes. However, the development of rural e-commerce significantly lags behind urban areas, particularly in the construction of e-commerce ecosystems, and Hainan is no exception. Hainan's diverse landscape, scattered villages, and low population density pose additional challenges.

Currently, the development of rural e-commerce in Hainan is relatively lagging, with no effective organizational and management models in place. The e-commerce ecosystem is still in its conceptual and nascent stages, facing several problems and challenges. First, the market and consumer demand for rural e-commerce in Hainan are insufficient. Compared to urban areas, rural markets are more dispersed, with farmers having low awareness and usage of e-commerce, lacking effective market promotion and publicity. Second, the infrastructure for the rural e-commerce ecosystem in Hainan is relatively weak, particularly in addressing the "last mile" logistics problem. The logistics, warehousing, and delivery services required for rural e-commerce are

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inadequate, with high logistics costs and slow efficiency, severely affecting the development and operational efficiency of rural e-commerce. Third, rural e-commerce lacks a unified management and operational model, with insufficient regulation and standardization. Given the diversity and differences in rural areas, the current management and operational models of rural e-commerce in Hainan are fragmented and unstandardized, lacking unified standards and regulations. Finally, there is a shortage of e-commerce talent in rural areas, with low willingness among university graduates to return to rural areas for employment and entrepreneurship. Structural employment issues are particularly pronounced in rural areas, with difficulties in talent cultivation and supply, limiting the rapid development of rural e-commerce.

3.4 Significant Gap in Digital Literacy Between Urban and Rural Residents

The disparity in education levels significantly contributes to the digital literacy gap between urban and rural residents, representing a key aspect of the digital divide in Hainan. On one hand, rural residents in Hainan generally possess lower digital literacy compared to their urban counterparts, with lower levels of digital skills and device usage, resulting in limited ability to apply digital technologies. On the other hand, rural residents often struggle with comprehending digital technologies and processing digital information effectively, which hampers digital development in these areas and widens the urban-rural digital gap. Additionally, the lag in digital infrastructure and services in rural areas restricts information transmission and communication efficiency, further exacerbating the digital divide. Enhancing the digital skills and application abilities of rural workers is essential for achieving coordinated urban-rural digital development. Addressing the need to promote digital literacy and application in rural areas to narrow the urban-rural digital divide is a pressing issue.

3.5 Disparity in Digital Development Levels Between Urban and Rural Areas

The development of the digital economy plays a crucial role in promoting coordinated urban-rural development, yet disparities in digital economy growth have led to uneven digital development levels between urban and rural areas in Hainan. Digital education and training are vital for improving the digital skills and information literacy of urban and rural residents. Urban areas have richer resources for digital education and training, providing residents with more opportunities for relevant training and learning. Conversely, in rural areas, the coverage and quality of digital education and training are relatively low, resulting in weaker digital skills among rural residents, which hampers overall coordinated development.

Urban areas have significantly higher ownership rates of digital infrastructure and services compared to rural areas. This digital divide restricts the economic and social development of rural areas and exacerbates governance gaps and inequities between urban and rural regions. The fundamental cause of the uneven digital development levels between urban and rural areas lies in systemic factors and market mechanisms that lead to differences in wealth accumulation. These differences cause disparities in digital development, resulting in uncoordinated growth levels. Due to differences in economic structures and unequal resource allocation, urban areas are better positioned to benefit from the digital economy, while rural areas lag behind. This imbalance in digital economy development impacts the transformation and upgrading of urban and rural industrial structures, thereby affecting the capability and level of coordinated urban-rural development.

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4 Impact of the Digital Divide on Coordinated Urban-Rural Development

4.1 Restrictive Effects of the Digital Divide on Economic and Social Development in Rural Areas

The digital divide restricts economic and social development in rural areas. Firstly, it leads to rural areas lagging in the digital economy, preventing them from enjoying the convenience and opportunities brought by digitalization. Secondly, the digital divide exacerbates the economic development gap between urban and rural areas, causing income disparity and social injustice. Additionally, the digital divide limits the improvement of public services such as education, healthcare, and culture in rural areas, further deepening urban-rural imbalances. Thus, narrowing the digital divide and promoting digital economy development in rural areas is crucial for achieving coordinated urban-rural development.

4.2 The Digital Divide Exacerbates Governance Gaps and Inequities Between Urban and Rural Areas

The digital divide not only negatively impacts coordinated urban-rural development but also exacerbates governance gaps and inequities. The prevalence of digital infrastructure and services is significantly higher in urban areas than in rural areas, leading to limitations and unfair treatment for rural residents in administrative services, education, healthcare, and financial services. Additionally, the disparity in digital technology application and innovation between urban and rural areas results in imbalanced development decisions, further increasing urban-rural divides in some cases. The existence of the digital divide also exacerbates inequalities in wealth and social welfare between urban and rural areas, potentially leading to social disharmony and conflict. Therefore, feasible policy measures and technical solutions must be implemented to address the digital divide, reduce disparities, promote coordinated urban-rural development, and achieve shared resources and mutual benefits between urban and rural areas.

4.3 The Imbalanced Dimensions of the Urban-Rural Digital Divide Affect Participation

The digital divide between urban and rural areas in Hainan manifests in at least three dimensions, affecting the participation of rural residents in the digital economy to varying extents. First, there is the digital access dimension. Urban and rural areas differ significantly in terms of internet access and digital production capabilities. Rural areas often suffer from inadequate digital infrastructure, limited application of digital technologies, and a lack of professional training in digital skills, resulting in weaker digital access capabilities among rural residents. Second, there is the digital usage dimension. Urban areas exhibit widespread application of digital technologies and a high level of digital economic development, whereas rural areas lack sufficient digital application scenarios and have relatively lower levels of digital technology usage and digital economic development. Third, there is the digital cognition dimension. Differences in digital literacy, skills, and technology application are evident between urban and rural areas. Influenced by educational levels, information access methods, cultural factors, and social environments, urban residents tend to have higher cognitive and operational abilities in digital technologies compared to their rural counterparts. These imbalances in different dimensions exacerbate the urban-rural digital divide, further widening the gap between these areas.

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5 Mechanisms of the Urban-Rural Digital Divide

The mechanisms underlying the urban-rural digital divide are multifaceted and complex, involving various factors such as policy, economy, education, and socio-cultural aspects. The primary factors include the following:

5.1 Economic Imbalance Leading to the Digital Divide

Economic imbalance is a crucial factor contributing to the digital divide between urban and rural areas. Firstly, market mechanisms and institutional factors such as policies have led to uneven economic development between cities and rural areas. Rural areas in Hainan lack sufficient economic resources, technological reserves, and scientific and technical support, resulting in a lower degree of digital technology application compared to urban areas. This disparity in digital economic support leads to differences and inequalities in the acquisition and utilization of digital information between urban and rural populations, inevitably exacerbating the digital divide.

Secondly, the faster economic growth rate in urban areas compared to rural areas results in higher levels of economic development in cities. This disparity directly influences the development of digital infrastructure and services, with urban areas being more capable of building and accessing digital resources due to their economic advantages, while rural areas lag behind due to economic constraints. Consequently, the widening digital divide hampers the pace of coordinated urban-rural development.

Furthermore, urban areas benefit from higher productivity levels compared to rural areas. The extensive and in-depth application of advanced technologies in cities promotes sustainable digital economic development. Digital technologies significantly drive and support economic growth, and the trend of digital transformation continues to unlock the potential of the urban digital economy, spurring overall market development. In the context of global digital economic integration, the ongoing expansion of the urban-rural digital divide further segregates urban and rural economies, leading to an imbalanced state of digital economic development and widening the wealth gap between urban and rural areas.

Lastly, the most apparent impact of the digital divide is its hindrance to the sustainable development of rural areas. When rural residents cannot access high-quality education, stable job opportunities, and superior healthcare, their potential for innovation and development is stifled. This directly affects their income, employment, education, healthcare, consumption, and investment. Consequently, the digital divide obstructs the sustainable development of rural regions.

5.2 Urban-Rural Resource Disparities Exacerbate the Digital Divide

The digital divide between urban and rural areas results in significant inequalities in access to information, knowledge, and skills. The substantial differences between cities and rural areas have already drawn attention due to disparities in material living conditions and educational levels. However, with the advancement of information technology, the impact of these urban-rural disparities on the digital divide has become increasingly pronounced. Data indicates that internet penetration in urban areas exceeds 70%, whereas in rural areas it is only around 30%. This highlights a clear inequality in access to and dissemination of information between

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cities and rural regions.

Educational resource disparities further deepen the digital divide. In urban areas, students benefit from excellent educational resources, such as advanced computer equipment, high-quality internet connections, and skilled teachers. Conversely, rural areas lack these resources, resulting in lower-quality education and significantly lagging development in information processing skills among rural students. The digital divide is evident not only in access to information and education but also in the proficiency of digital skills. In cities, the well-established technological ecosystem enables easy acquisition and mastery of modern skills, driving innovation and competitiveness. In rural areas, the lack of these skills hampers the ability of residents to keep pace with modernization, widening the economic and social development gap between rural and urban areas.

Urban areas have well-developed and widely applied digital facilities and services, while rural areas lag in both the prevalence and application of digital technologies. This growing disparity in resources between urban and rural areas continually exacerbates the digital divide. Specifically, urban digital service platforms are continuously improving, and digital economic growth is sustained, whereas rural areas lack comprehensive digital service platforms and support for digital economic development, deepening the digital divide. The complex mechanisms driving the digital divide involve various factors, including policies, technologies, and market forces, making it challenging to resolve these disparities in a single step.

5.3 Institutional Factors Contributing to the Digital Divide

Institutional factors play a significant role in the existence and exacerbation of the urban-rural digital divide. One primary issue is the inadequate attention by government departments to the imbalance in urban and rural development, resulting in a policy orientation that favors urban development. Government investments and policy support are often directed more toward urban areas, such as the rapid progress in infrastructure projects like highways and high-speed rail, which are predominantly concentrated in cities. Urban areas also benefit from more favorable policies and capital concentration, which support the development of digital facilities and services. In contrast, rural development is often passive and lacks the necessary policy guidance and support, leading to delayed digital infrastructure construction and the promotion of digital services.

Moreover, the unequal distribution of social wealth under the market economy mechanism is another critical institutional factor exacerbating the digital divide. Urban areas, with dense populations and large market scales, generate more economic value, while rural areas, with smaller populations and market scales, have relatively weaker market competitiveness and cannot match urban areas. Additionally, the relatively underdeveloped infrastructure in rural areas and the lack of skilled labor further limit the production capacity and economic income levels of rural regions.

6 Recommendations for Bridging the Urban-Rural Digital Divide and Promoting Coordinated Development

6.1 Enhancing Government Guidance and Market Integration

At the policy level, it is crucial to strengthen government guidance and market integration to reduce the

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digital divide and promote coordinated urban-rural development. Specifically, a favorable policy environment should be created by improving relevant laws and regulations, accelerating the construction of digital infrastructure, and encouraging and supporting the development of digital industries. Additionally, market integration and resource allocation need to be enhanced to establish urban-rural digital service platforms that foster complementary digital economic development between urban and rural areas. Both government and market forces should play a collaborative role in narrowing the digital divide and advancing coordinated urban-rural development.

6.2 Improving Rural Software and Digital Infrastructure

Hainan Province has achieved 100% fiber-optic broadband coverage in its administrative villages, with a coverage rate of over 99.51% for natural villages with more than 20 households. However, the accompanying software and digital infrastructure and service availability in rural areas are significantly lower than in urban areas, leading to a lower level of digital application in rural areas and hindering their economic development. To narrow this digital divide, it is necessary to systematically plan the construction of software and hardware infrastructure. Firstly, optimize and upgrade the hardware infrastructure to address the shortcomings in rural digital development. While ensuring stable internet supply, each city and county should establish unified data management centers for rural areas, specifying technical standards and norms to support the basic infrastructure for rural digital applications and improve overall operational efficiency. Simultaneously, reduce the cost of network use in rural areas through policy support and market adjustment to make network services more affordable for more farmers. Secondly, accelerate the digital transformation of rural traditional infrastructure. Build a rural cloud computing platform, develop digital application scenarios, provide data storage, processing, and analysis capabilities for rural areas, and support the operation of various applications. Utilize technologies such as the Internet of Things and big data to improve the intelligence level of agricultural production, increase agricultural productivity and quality. Establish a rural e-commerce platform to expand sales channels for farmers and increase their income. Promote mobile payment and internet financial services to improve the coverage and convenience of financial services in rural areas. Promote remote medical services to improve the efficiency of medical resource utilization in rural areas and improve medical service levels. Lastly, enhance the digital literacy skills of farmers, conduct digital skills training, improve the digital literacy of rural residents, and enable them to better use digital tools, proficiently use digital devices and services.

6.3 Cultivating the Modern Agricultural Information Industry to Enhance Rural Information Dissemination Capability

To strengthen the narrowing of the urban-rural digital divide and promote coordinated urban-rural development, attention should be focused on the digital development of rural areas and gradually improve their information dissemination capabilities. Firstly, cultivate the modern agricultural information industry. The government can increase support for the research and promotion of digital agricultural technologies, guide enterprises to increase investment and innovation in agricultural informatization, and promote the deep integration of modern agriculture and the digital economy. Secondly, establish a rural digital service platform. Build a rural digital service network and use existing information technologies to provide farmers with comprehensive and multi-field digital services, such as agricultural product trading, agricultural insurance, rural

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e-commerce, etc. Thirdly, enhance rural information dissemination capabilities. Establish a mechanism for rural information training, organize regular training activities for rural information, improve farmers' ability to acquire and use information, and promote the application and popularization of digital technology in rural areas. Lastly, strengthen digital industry poverty alleviation. The government can encourage the development of the digital industry through tax reductions, fiscal subsidies, etc., promote the application of digital technology in rural areas, and provide new impetus for the development of the digital economy in impoverished areas.

6.4 Strengthening Talent Cultivation and Skills Enhancement

In the digital age, improving farmers' digital literacy is an important way to narrow the urban-rural digital divide and cultivate knowledgeable farmers. It is necessary to attach importance to talent cultivation and skills enhancement in rural areas and promote the balanced development of digital skills for urban and rural labor. Firstly, increase efforts in talent cultivation and improve the training level of rural digital talents. The government should increase investment, support the construction of digital talent training centers, and strengthen the training and cultivation of rural digital talents. Secondly, conduct digital skills training to improve the digital literacy of urban and rural residents. Conduct various forms of digital skills training to familiarize the general urban and rural residents with basic knowledge of digital technology and master digital application capabilities. Thirdly, optimize talent policies and guide talents to flow to grassroots levels. The government can formulate preferential policies to encourage talents to work at the grassroots level, improving the level of digital construction in grassroots areas. Lastly, strengthen research and innovation in digital technology applications, and improve the application level of digital technology. Increase investment in research on digital technology applications, attract outstanding talents from all walks of life to join in research and innovation of digital technology applications, and promote the innovation and renewal of digital technology applications.

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