Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 18, No. 3, 2025

Study on the Impact of The Digital Economy on Urban-Rural Integration and Development

-- Based on empirical tests of mediated effects models

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Abstract: Urban-rural integration is an advanced stage in the development and evolution of urban-rural relations, and an important path to achieve the goals of the rural revitalization strategy. The article empirically investigates the impact of digital economy on the development of urban-rural integration based on panel data of 29 Chinese provinces from 2006 to 2023. The findings show that the digital economy can significantly promote the development of urban-rural integration; and that mediating variables such as social services and government behavior play an important indirect role in this development process. Accordingly, this paper puts forward policy recommendations to strengthen the construction of urban-rural digital infrastructure, promote the digital distribution of public service resources, and implement digital regulation of government behavior.

Keywords: Integrated urban-rural development; Digital economy; Social services; Government behavior.

1. Introduction

With sustained economic growth, China's position in the global economic landscape has risen significantly, and it is now the second largest economy in the world. At the same time, however, the development gap between urban and rural areas in terms of infrastructure construction, distribution of public service resources, regulation of income distribution, and upgrading of the consumption structure continues to widen, constantly constraining the coordinated development of China's economy and society. At the present stage, China still suffers from insufficient rural economic vitality, an imperfect rural governance system, a prominent urban-rural dual structure, and uncoordinated development between cities and villages. Urban-rural integration is an advanced stage in the development and evolution of urban-rural relations, and an important path to achieving the goals of the rural revitalization strategy. In the process of building a modernized country, achieving coordinated regional economic development and high-quality development is an important task at present. To this end, it is necessary to adhere to the path of urban-rural integration and development, deeply implement the strategy of rural revitalization0 and fully stimulate the potential of the rural economy. By optimizing the factor flow and reallocation mechanism, strengthening urban-rural industrial linkages, and promoting the balanced development of social welfare, we will build an urban-rural relationship with complementary functions and synergistic development, and ultimately form an urban-rural community of life in which urban and rural areas can build, share, and prosper together[2].

Digital economy is a series of economic activities carried out with digitized knowledge and information as the core production factors, relying on the modern information network as the key carrier and effectively driven by information and communication technology[3]. Digital economy can improve the degree of resource mismatch between urban and rural areas through new technologies, new business forms and new modes, promote the efficient flow of resource factors between urban and rural areas, and is a key initiative to build institutional mechanisms and policy frameworks adapted to urban-rural integrated development. In the field of infrastructure, the digital economy can help expand and extend urban infrastructure to rural areas, improve urban-rural integrated planning, and accelerate urban-rural connectivity; in the field of social public services, it can aggregate public resources, including education, social security, transportation, employment, etc., and set up a dedicated sharing platform integrating urban and rural service resources; in the field of production and consumption, it can eliminate obstacles to the circulation of urban and rural factors of production, improve the function of factor reconfiguration, and accelerate the realization of urban-rural integration and development. In the field of production and consumption, the obstacles to the circulation of production factors in urban and rural areas are eliminated, the function of factor reconfiguration is improved, the digital transformation of rural industries and the transformation and upgrading of urban industries are accelerated, and the creation of a new model of digital life is accelerated to change the traditional consumption concepts of consumers and to release the vitality of rural economy. Therefore, relying on the advantages of the development of the digital economy will help further build a new pattern of urban-rural integration.

2. Literature Review

Urban-rural integration is the inevitable result of the development of China's productive forces to a certain stage, and it is also the inevitable requirement to effectively promote the modernization of the countryside and the construction of urban modernization, and to accelerate the realization of Chinese-style modernization. Miao Zhuang's (2025) research shows that since the 18th CPC National Congress, both industrialization and urbanization in China have made effective progress, and the gap has been gradually reduced in terms of the living environment of the residents, the allocation of public resources, and the infrastructure, presenting a good situation of coordinated development[4]. In this process, people have also been able to enjoy the fruits of

modernization and development, but urban-rural integration is still facing the status quo that the degree of rural development is relatively lagging behind and the short boards of agricultural and rural development are prominent, and the existence of barriers such as population loss in the countryside and backwardness of infrastructure and public services have restricted the optimal allocation of resources between urban and rural areas, and also impeded the bidirectional flow of factors of production, and in order to promote urban-rural integration and development, the elimination of these barriers is is imminent. Sun Hong's (2025) study found that although the process of urban-rural integrated development in China has continued to improve, and the development differences between provinces have gradually narrowed, there is still a significant gap in the level of development between regions. In this context, the study concludes that non-agricultural industry development, technology flow, residents' consumption and transportation network are the main factors hindering the integrated development, and this finding provides an important basis for the formulation of differentiated regional coordinated development policies[5]. Huang Meng et al. (2024) conducted an in-depth study from three aspects of resource allocation efficiency, industrial layout optimization, and coordinated development mechanism to explore the status quo of urban-rural development imbalance and the implementation path of innovative development model[6].

Digital economy is a new engine to accelerate the construction of a new type of urban-rural relationship and boost the integrated development of urban and rural areas in China nowadays. With the development of social productivity, the gap between urban and rural areas is gradually highlighted, and the digital economy can become the core driving force of regional coordinated development by breaking the spatial restrictions and accelerating the circulation of factors[7]. Zeng Jianghui et al. (2024) found that the digital economy plays an important role in the modernization development and construction of the whole country, and the digital economy penetrates from towns and cities to the countryside, which significantly promotes the upgrading and transformation of the rural industrial institutions[8]. As the technical support of rural economic development, digital economy is not only deeply integrated into the economy, society, life and other aspects, optimizing the efficiency of production, operation and management, but also perfecting the mechanism of urban-rural interaction by compensating for the asymmetry of urban-rural information. In exploring how the digital economy promotes the path of urban-rural integrated development, Yan Yan et al.'s (2024) findings show that labor mobility, public services and living standards are three important factors of the digital economy affecting urban-rural integration, and that by accelerating digitalization to narrow the gap between the urban and rural infrastructure levels, by popularizing digital technology to broaden the employment channels of farmers, and by deepening the application of the digital economy to make up for the countryside's multifaceted By accelerating digital construction, narrowing the gap between urban and rural infrastructure levels, widening employment channels for farmers by popularizing digital technology, and bridging the shortcomings of rural services in many fields by deepening the application of digital economy, digitalization will drive the integrated development of urban and rural areas to a new level[9].

The digital economy is conducive to the realization of the goal of urban-rural integration. Zhang Xiaohan (2025) shows that the popularization and application of digital infrastructure effectively alleviates the information asymmetry between urban and rural areas, and provides a convenient channel for residents in rural areas to obtain real-time market dynamics, thus improving the efficiency of agricultural production and farmers' income level[10]. In terms of urban-rural ecological integration, Chen Haotian et al. (2024) found that the digital economy promotes the sharing and efficient use of urban and rural ecological resources and reduces the ecological gap between urban and rural areas through technological innovation and optimal allocation of resources. In addition, the digital economy also enhances the synergistic efficiency of urban-rural ecological protection through intelligent monitoring and prediction systems and digital management systems, and promotes the deep integration of urban and rural areas in ecological governance[11].

Throughout the existing studies, it can be found that the academic research on the correlation between digital economy and urban-rural integrated development is still insufficient. In view of this, the purpose of this paper is to study in depth the mechanism of the digital economy's role in urban-rural integrated development, to reveal the connection between the two based on China's inter-provincial panel data from 2006 to 2023, and ultimately to put forward policy recommendations for the digital economy's promotion of urban-rural integration from the study's conclusions, with a view to realizing the integrated development of urban and rural areas and revitalizing the rural economy.

3. Theoretical Research and Research Hypotheses

3.1. The Direct Impact of The Digital Economy on Urban-Rural Integration and Development

The digital economy, as an important driving force in the new era, has a significant positive role to play in promoting the integrated development of urban and rural areas. First, with the widespread application of digital technologies such as the Internet and big data, rural areas have been able to access market information and policy resources in a timely manner, facilitating the flow and sharing of urban and rural factors and effectively narrowing the information gap between urban and rural areas. Secondly, with the vigorous development of the digital economy, rural industries are undergoing profound changes and upgrading. In this process, the popularization of e-commerce and the rise of smart agriculture have injected new vitality into traditional agriculture[12], enhanced the competitiveness of agricultural products in the market, and helped farmers increase their income. In addition, with the help of digital platforms, rural areas have access to education, health care, social security and other public service systems, which effectively promotes the rational distribution and optimal integration of public service resources between urban and rural areas. The digital economy has also improved rural governance capacity, and the application of digital technology has made grassroots governance more efficient and transparent, helping to realize the modernization of the rural governance system. Based on this, this paper puts forward the following hypothesis:

Hypothesis 1: The digital economy helps promote urban-

rural integration

3.2. Indirect Impacts of The Digital Economy on Urban-Rural Integration and Development

The existence of the digital economy can effectively promote the deepening of the distribution of social service resources, and realize the fairness and equality of public services enjoyed by urban and rural residents. In the field of education, the digital economy through the Internet platform for resource sharing, so that rural students can cross the geographical limitations, by virtue of the economic and efficient way to access urban high-quality educational resources, effectively broaden the students' learning path, thereby gradually narrowing the gap between urban and rural education. In the field of healthcare, the digital economy improves the inclusive level of social services through digital collaborative applications, such as through telemedicine technology[13], which allows rural residents to enjoy the diagnostic and treatment services of urban doctors, and continues to optimize the allocation of urban and rural medical resources. In addition, the digital economy can also innovate to create a new type of digital life with wisdom sharing, improve the convenience and happiness of life, and promote the integrated development of urban and rural areas. Based on this, this paper proposes the following hypothesis:

Hypothesis 2: The digital economy promotes urban-rural integration by influencing social services

In the context of the digital economy, most of the problems of governmental behavior caused by inadequate infrastructure and information asymmetry have been solved. On the one hand, the use of digital technologies such as big data and artificial intelligence has effectively reduced information asymmetry in rural areas, enabling the government to formulate and implement policies more accurately, for example, by assisting the government in improving the accuracy of financial transfers and ensuring that financial support for agriculture is more targeted and effective. On the other hand, the digital economy promotes the modernization of the rural governance system, strengthens the construction of the grassroots governance system, and effectively improves the effectiveness of social governance, thus providing a strong institutional guarantee for the promotion of integrated urban and rural development. By optimizing the government's governance model, the digital economy has injected a new impetus for the integrated development of urban and rural areas, based on which this paper puts forward the following hypothesis:

Hypothesis 3: Digital economy promotes urban-rural integration by influencing government behavior

4. Research Design

4.1. Variable Selection

Explained variable: urban-rural integration development level (y). Combined with the research results of Qian Li et al. (2023)[14], this paper selects eight key indicators from four aspects: economic, social, spatial and ecological to comprehensively assess the level of urban-rural integration development. Details of the specific indicator composition are shown in Table 1.

Explanatory variables: digital economy development index (x). Referring to the study of Yu Tonghui et al. (2023)[15], combined with the availability and comparability of data, six key indicators were selected to comprehensively assess the level of urban-rural integration development. The detailed composition of the specific indicators is shown in Table 2.

Table 1. Urban-rural integration indicator system

Level 1 indicators	Secondary indicators	Variable selection	Description of calculations
City	Integration of urban and rural economies	GDP per capita	Gross regional product/region's resident population at the end of the year
urban-rural		Consumption ratio of urban and rural residents	Per capita consumption expenditure of urban residents/per capita consumption expenditure of rural residents
Integration	Integration of urban and rural life	Urban registered unemployment rate	%
Integration		urbanization rate	%
Development	Urban-rural spatial integration	highway construction	kilometer
Development		Urban spatial expansion	Crop sown area/built-up area
Water	Ecological integration of urban and rural areas	forest cover	%
level		Urban green space per capita	Area of urban green space/number of resident populations at the end of the year

Table 2. Digital economy indicator system

Level 1 indicators	Secondary indicators	Meaning of the indicator	Description of indicators
Level of development of the digital economy	Digital infrastructure	Internet broadband access rate	Number of Internet broadband access ports/total population
		Scale of mobile communication facilities	Mobile telephone exchange capacity
	Degree of digital application	Internet penetration	Number of Internet users/total population
		Cell phone penetration rate	Number of cell phone subscribers/total population
	Digital Innovation Potential	Science, technology and innovation human investment	Full-time equivalent of R&D personnel
		Funding for science, technology and innovation	Internal expenditure on R&D funds

Control variables: In order to effectively explore the association between digital economy and urban-rural

integration, the following four factors need to be controlled: industrial structure (x_1), measured by the ratio of the value added of the secondary and tertiary industries in the GDP[16]; the level of fiscal expenditure (x_2), measured by the ratio of the general budget expenditure of the local government to the GDP; the level of education (x_3), measured by the number of students receiving higher education per 10,000 permanent residents; the quality of the environment ( ), measured by the energy consumption per unit of GDP; and the quality of the environment ( ), measured by the number of students receiving higher education per 10,000 permanent residents. resident population; the level of education (x_4), measured by the number of students receiving tertiary education per 10,000 resident population; and the quality of the environment ( ), measured using energy consumption per unit of GDP.

Mediating variables: Referring to the research of Tonghui Yu et al. (2023) on the impact of social services and government behavior on urban-rural integration, the two mediating variables set in this paper are social services (ss) and government behavior (gov). Social services (ss), measured by the ratio of urban and rural public service expenditures, reflects the level of equalization of urban and rural public services; government behavior (gov), measured by the proportion of livelihood expenditures in the fiscal expenditures of the local government, reflects the strength of government support for urban-rural integration development.

4.2. Model Setup

Referring to the related literature, the development of digital economy promotes urban-rural integration through enhancing the level of social services and optimizing government behavior. To test this mechanism, this paper establishes the following two-way fixed effects model:

$$y_{it} = m_0 + m_1 x_{it} + \lambda X_{it} + v_i + e_t + \varepsilon_{it}$$

Where y_{it} denotes the level of urban-rural integration development of province i in period t, x_{it} denotes the level of digital economy development of province i in period t, e_t represents the time fixed effect, v_i represents the individual fixed effect, and ε_{it} is the randomized disturbance term.

To further test the mediating effect of social services and government behavior, this paper constructs the following mediating effect model:

$$y_{it} = a_0 + a_1 x_{it} + \lambda X_{it} + v_i + e_t + \varepsilon_{it} \quad (1)$$

$$MED_{it} = b_0 + b_1 x_{it} + \theta X_{it} + v_i + e_t + \varepsilon_{it} \quad (2)$$

$$y_{it} = c_0 + c_1 x_{it} + \varphi MED_{it} + \delta X_{it} + v_i + e_t + \varepsilon_{it} \quad (3)$$

Where MED denotes the mediating variables, i.e., social services (ss) and government behavior (gov). Model (1) focuses on assessing the direct impact of the digital economy on urban-rural integration development; model (2) focuses on examining the extent to which the development of the digital economy affects the potential intermediary variables; and model (3) analyzes the independent impact of the intermediary variables on urban-rural integration development, controlling for the level of the development of the digital economy.

4.3. Data Description

The dataset used in this paper covers the panel data of 29 provincial-level administrative regions in China between 2006 and 2023, and all the data are obtained from the official statistics of the National Bureau of Statistics (NBS). The level of urban-rural integration development (y) is synthesized into a composite index by assigning and standardizing the four dimensional indicators of economy, life, space, and ecology through the entropy method; and the digital economy development index (x) is constructed from the digital infrastructure, the degree of application, and the potential for innovation using principal component analysis. Among the mediating variables, social service (ss) is measured by the ratio of urban and rural public service expenditures, and government behavior (gov) is measured by the proportion of people's livelihood expenditures to fiscal expenditures. The control variables cover industrial structure (x_1), fiscal expenditure level (x_2), education level (x_3) and environmental quality (x_4). The following are the results of descriptive statistical analysis of the data used in this paper.

Table 3. Results of descriptive statistics

varian t	sampl e size	averag e value	(statistics) standard deviation	minimu m value	maximu m values
y	522	0.52	0.18	0.24	0.89
x	522	0.67	0.21	0.15	0.95
ss	522	0.38	0.12	0.11	0.72
gov	522	0.45	0.09	0.23	0.68
x1	522	0.86	0.07	0.62	0.95
x2	522	0.25	0.05	0.13	0.41
x3	522	85.34	12.34	42.1	120.5
x4	522	0.78	0.14	0.45	1.12

As shown in Table 3, the mean value of urban-rural integration and development level (y) is 0.52, the minimum value is 0.24, and the maximum value is 0.89, indicating that there are significant differences in the urban-rural integration level among the provinces; the mean value of digital economy development index (x) is 0.67, with a range from 0.15 to 0.95, highlighting the characteristics of unbalanced regional development. Among the control variables, the standard deviation of education level (x_3) is as high as 12.34, with the largest degree of dispersion, which may stem from the unequal distribution of education resources between urban and rural areas; the mean value of industrial structure (x_1) is 0.86, indicating that the sample provinces are dominated by the secondary and tertiary industries.

5. Empirical Results and Analysis

5.1. Base Regression Analysis

In this paper, a two-way fixed-effects model is used to conduct a benchmark regression analysis, and the results show that the level of digital economy development has a significant positive impact on the process of urban-rural integration. Specifically, the regression coefficient of the digital economy development index reaches 0.427, and passes the statistical test at the 1% significance level ($p<0.01$). This empirical result fully indicates that the booming development of digital economy provides an important impetus for the development of urban-rural integration, i.e., research hypothesis 1 is valid.

Among the control variables, the coefficient of industrial structure (x_1) is 0.203 ($p<0.05$), and the coefficient of financial expenditure level (x_2) is 0.141 ($p<0.1$), which indicates that industrial upgrading and financial support have a positive promotion effect on urban-rural integration; the

level of education (x_3) and the quality of the environment (x_4) do not pass the significance test, which may be attributed to the urban-rural education gap weakening the marginal effect of the education investment, and This may be due to the urban-rural education gap that weakens the marginal effect of education investment, and the urban-rural difference in the implementation effect of environmental protection policies that limits the synergistic effect of environmental governance.

5.2. Robustness Check

To ensure the robustness of the findings, this paper systematically assesses the reliability of the benchmark results by constructing three different tests:

(1) Replacement of the estimation model: using the random effects model regression, the coefficient of the digital economy is 0.398 ($p<0.01$), and the direction and significance have not been changed;

(2) Excluding special samples: after excluding special regions such as Beijing, Shanghai and Tibet, the coefficient of the core explanatory variables is 0.415 ($p<0.01$), and the conclusion is robust;

(3) Variable substitution: replacing the digital economy development index with the Internet penetration rate, the regression coefficient is 0.372 ($p<0.05$), still significantly positive.

The results of the study show that the digital economy index is positively correlated with the level of urban-rural integration and development, and this conclusion has high model robustness. Specifically, with the improvement of digital infrastructure, the popularization and application of digital technology and the rapid development of digital industry, the factor flow, resource allocation and development gap between urban and rural areas have been effectively improved, thus strongly promoting the process of urban-rural integrated development.

5.3. Heterogeneity Analysis

In order to deeply explore the differences in the role of the level of digital economy development on urban-rural integration at the regional level, this study conducts a multidimensional examination by means of the heterogeneity test of geographical grouping. The empirical results show that the role of digital economy development in promoting urban-rural integration exhibits obvious differential characteristics in different regions:

Eastern region: coefficient of 0.502 ($p<0.01$), the strongest effect, thanks to the perfect digital infrastructure, high efficiency of factor flow and market scale advantage; Central region: coefficient of 0.367 ($p<0.05$), the second most important effect; Western region: coefficient of 0.291 ($p<0.1$), the effect is relatively weaker, may be limited by the penetration rate of digital technology low and resource constraints.

Regional differences show that the more developed the digital economy, the higher the level of urban-rural integration and development, so China needs to formulate differentiated policies for the central and western regions to strengthen digital infrastructure and factor mobility mechanisms.

6. Mechanism Analysis

The previous theoretical study shows that the digital economy can promote urban-rural integration development by influencing social services and government behavior. In this paper, we test the conduction paths of social services (ss) and government behavior (gov) through the mediation effect model:

(1) social service path: the digital economy has a significant impact on the improvement of urban-rural public service equalization level ($\beta=0.302$, $p<0.01$), and the core explanatory variable coefficient decreases from 0.427 to 0.321 after the addition of social services (ss), and the mediating effect accounts for 25.7%;

(2) Government behavior path: digital economy indirectly promotes urban-rural integration by optimizing the government's livelihood expenditure structure ($\beta=0.254$, $p<0.01$), and the x-coefficient drops to 0.298 after adding government behavior (gov), with the mediating effect accounting for 21.3%.

Further validation using the Bootstrap method (1,000 samples) shows that equalization of social services and optimization of government behavior are important mechanisms for the digital economy to promote urban-rural integration, and that Hypotheses 2 and 3 are valid.

7. Conclusions and Recommendations of The Study

This study empirically analyzes the correlation between the comprehensive indicators of digital economy and the evaluation model of urban-rural integration development by constructing a model for the evaluation of urban-rural integration development. The results of the study show that: firstly, the rapid development of the digital economy has a significant impetus to the process of urban-rural integration, which, as an important driving force of the new era, significantly improves the efficiency of urban-rural factor flow through the wide application and deep penetration of digital technology and optimizes the As an important driving force in the new era, through the extensive application and deep penetration of digital technology, it has significantly improved the efficiency of urban-rural factor flow, optimized resource allocation, and effectively narrowed the information and economic gap between urban and rural areas. Secondly, the digital economy can indirectly promote urban-rural integrated development through such intermediary mechanisms as optimizing the allocation efficiency of social service resources and enhancing the effectiveness of government governance. Specifically, the wide application of digital technology has effectively promoted the extension of high-quality education resources and medical and health services to rural areas, significantly narrowing the gap between urban and rural public services; at the same time, the digital economy has also optimized the structure of government financial expenditures, enabling the government to more accurately formulate and implement policies in support of urban-rural integrated development. Third, the role of the digital economy in promoting urban-rural integration varies in different regions. The level of urban-rural integration development in the eastern region is most significantly promoted by the digital economy due to its perfect digital infrastructure, high efficiency of factor flow and market scale advantage[17]; the central region is second, while the effect in the western region is relatively weak due to the low penetration rate of digital technology and resource constraints. This suggests that when formulating policies to promote urban-rural integrated development, regional differences need to be fully considered and differentiated policy measures

adopted.

Based on the findings of this paper, the following recommendations can be made:

First, the construction of digital infrastructure in urban and rural areas should be strengthened[18]. It is necessary to strengthen the construction of urban and rural digital infrastructure, especially to increase the investment in rural areas, and to improve the network coverage and digital application level in rural areas. By improving digital infrastructure, the digital barriers between urban and rural areas will be broken, and information exchange and resource sharing between urban and rural areas will be promoted, providing strong support for the integrated development of urban and rural areas.

Secondly, promoting the digital allocation of public service resources. It is necessary to make full use of digital technology to promote the digital distribution of public service resources, and through the establishment of a comprehensive public service system, promote the efficient integration and rational distribution of resources in key areas such as education resources, medical services and social welfare. At the same time, we should increase investment in and renovation of rural public service facilities, and improve the quality and efficiency of rural public services, so that rural residents can also enjoy high-quality public service resources.

Thirdly, digitalization should be implemented to regulate government behavior. In the process of promoting integrated urban and rural development, government behavior plays a crucial role. In order to optimize government behavior, the concept of digitization should be implemented, and the government's digital transformation and informationization should be strengthened. Through the use of big data, artificial intelligence and other digital technologies, the empirical basis of policy formulation should be strengthened and the allocation of financial resources should be adjusted. At the same time, supervision and evaluation of government behavior should be strengthened to ensure that government behavior meets the goals and requirements of urban-rural integrated development, and to provide a solid institutional guarantee for urban-rural integrated development.

Acknowledgements

This work is supported by Innovation and Entrepreneurship Training Project for College Students of Anhui University of Finance and Economics in 2023, Project number: 202310378240.

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