

The Impact of Digital Economy on the Integrated Development of Urban and Rural Areas: An Analysis based on the Upgrading of Industrial Structure

Chengyan Zhou*

School of Economics, Anhui University of Finance and Economics, Bengbu, Anhui, China

*Zhouchengyan0502@126.com

Abstract

Based on the panel data of 31 provinces in China from 2012 to 2023, this paper empirically analyzes the impact mechanism of digital economy on urban-rural integration and development, and focuses on the intermediary role of industrial structure upgrading. The findings are as follows: (1) Digital economy has significantly promoted the development of urban-rural integration, and this effect is more prominent in eastern China; (2) Mechanism analysis shows that digital economy indirectly narrows the gap between urban and rural areas and promotes the integrated development of urban and rural areas by promoting the upgrading of industrial structure; (3) In the robustness test, the measurement method of replacing core variables and shortening sample time range is adopted, and the conclusion is still valid. The research in this paper provides important enlightenment for policy makers, and suggests to realize the coordinated development of urban and rural areas by optimizing the structure of digital industry.

Keywords

Digital Economy; Urban and Rural Integration; Upgrading the Industrial Structure; Intermediary Effect.

1. Introduction

In recent years, the relationship between digital economy and urban-rural integrated development has received extensive attention from academic circles. Existing research shows that the digital economy can promote the integrated development of urban and rural areas by optimizing the allocation of factors, improving market efficiency, and promoting the equalization of public services. Guo Feng [1] et al. pointed out that digital technology has broken the geographical restrictions of the traditional urban-rural dual structure, making the flow of capital, technology and information between urban and rural areas more efficient, thus narrowing the urban-rural development gap. The rise of rural e-commerce has significantly increased farmers' incomes [2] by shortening the circulation chain of agricultural products. However, some scholars believe that the gap between urban and rural digital infrastructure and residents' digital skills may lead to a "digital divide", which may exacerbate the urban-rural development imbalance [3] in the short term.

In terms of the impact of digital economy on the upgrading of industrial structure, it is generally believed that digital technology plays a role by promoting industrial upgrading and rationalization. On the one hand, the application of digital technologies such as artificial intelligence and big data has promoted the transformation [4] of traditional industries to high value-added and high-tech directions; On the other hand, the development of the platform economy has optimized the efficiency of resource allocation and promoted the coordinated development [5] of the three industries. It is worth noting that this optimization effect of the

digital economy on the industrial structure may further affect urban-rural relations. Lu Ming et al.'s [6] research shows that an increase in the proportion of the tertiary industry can absorb more surplus rural labor, thereby narrowing the urban-rural income gap.

Although the existing research has provided an important foundation for understanding the relationship between digital economy, industrial structure upgrading and urban-rural integrated development, there are still some shortcomings. For example, most of the researches focus on the direct effects of digital economy and the treatment of the endogenous problems of models need to be strengthened. This paper attempts to make a marginal contribution to the research in this field by constructing a more perfect theoretical framework, adopting multi-dimensional indicators and more rigorous measurement methods.

2. Theoretical Analysis and Research Hypothesis

2.1. Influence Mechanism of Digital Economy on Urban-rural Integration Development

Digital economy plays a significant role in promoting urban-rural integration through multiple channels. First, the digital economy has improved the effect of urban-rural talent integration. Second, the digital economy has strengthened the integration of factor markets. Digital platforms have significantly reduced transaction costs for factor flows through transparency of information and ease of transaction. Third, the digital economy has promoted the equalization of public services. These changes have created a fairer institutional environment for the integrated development of urban and rural areas.

Based on this, this paper proposes the following hypothesis:

H1: Digital economy can promote the integration of urban and rural development.

2.2. The Role of Industrial Structure in the Digital Economy in Promoting Urban-rural Integrated Development

By promoting the upgrading of industrial structure, the digital economy plays a key role in promoting the integrated development of urban and rural areas. Specifically, on the one hand, the development of digital economy has created new job opportunities and improved production efficiency in rural areas by promoting the path of industrial upgrading such as the digitization of agriculture and the intelligent service industry. On the other hand, by reducing transaction costs and improving the flow of factors and other industrial rationalization paths, it has strengthened the industrial links between urban and rural areas and narrowed the development gap. Based on this, this paper puts forward the following research hypothesis:

H2: Industrial structure upgrading plays an intermediary role in the digital economy promoting urban-rural integration.

3. Model Setting and Variable Selection

3.1. Selection of Measurement Methods

In this paper, the least square method of econometrics is used to regression the data, using fixed effects model (re) and random effects model (fe) respectively. Through Hausmann test, it is concluded that the fixed effects model is more effective. Therefore, the fixed effects model is used for regression in this paper.

3.2. Data Source and Variable Selection

Table 1. Descriptive statistics

VarName	Obs	Mean	SD	Min	Median	Max
Cxrhfz	403	0.356	0.099	0.112	0.353	0.659
Digi	403	0.134	0.116	0.007	0.101	0.747
Struc	403	1.295	0.732	0.518	1.144	5.690
lnPgdp	403	10.928	0.462	9.706	10.900	12.207
Govern	403	0.094	0.045	0.021	0.095	0.204
Industr	403	0.418	0.087	0.149	0.425	0.590
Urbani	403	59.688	12.922	22.810	59.070	89.600
lnOpen	403	5.508	0.984	2.396	5.382	7.782

Data in this article are mainly from the National Bureau of Statistics and provincial statistical yearbooks, with some data from EPS Global statistics. The main variables in this paper and their measurement methods are as follows.

Explained variable: Urban-Rural integrated development (Cxrhfz). Learn from the research of Shao Yingying, Li Xiao et al. [7, 8], as shown in Table 2.

Table 2. Indicator system of urban-rural integration development

First-level indicators	Secondary indicators	Tertiary indicators	Attributes
Economic integration	Level of economic development	Per capita GDP	+
	Urban-rural income gap	Urban per capita disposable income/rural per capita disposable income	-
	Expenditure gap between urban and rural residents	Per capita consumption expenditure of urban residents/per capita consumption expenditure of rural residents	-
	Binary correlation coefficient	(Gross product of primary industry/employment in primary industry)/(Gross product of secondary and tertiary industry/Employment in secondary and tertiary industry)	+
Social integration	Urban and rural pension insurance coverage	Number of old-age insurance participants/permanent resident population of urban and rural residents	+
	Unemployment insurance coverage	Number of persons participating in unemployment insurance/number of permanent residents	+
	Comparison coefficient of medical care per capita between urban and rural areas	Per capita health care expenditure of urban residents/health care expenditure of rural residents	-
	Registered urban unemployment rate	Direct data	-
	Urban and rural education input	Education expenditure/fiscal expenditure	+
Spatial integration	Private car ownership	Direct data	+
	Urbanization rate	Urban population/total population	+
	Comparison coefficient of transport and communication per capita between urban and rural areas	Per capita transportation and communication expenditure of urban residents/transportation and communication expenditure of rural residents	-
Ecological integration	Harmless treatment of domestic waste	Direct Data	+
	Forest cover	Direct data	+
	Public toilet access	Public toilets for every 10,000 people	+

Explanatory variable: Digital Economy (Digi). Drawing on the research of Wu Jianhui[9] et al., this paper measures the level of digital economy from the three dimensions of digital infrastructure, digital industrialization and industrial digitalization, and uses the entropy method to get the digital economy index. It is shown in Table 3.

Table 3. Digital economy index system

First-level indicators	Secondary indicators	Stats
Digital infrastructure	Internet broadband access rates	+
	Internet broadband penetration	+
	Mobile phone facility size	+
	Length of long distance optical cable lines	+
	Number of pages	+
	Number of domain names	+
Digital industrialization	Total telecommunications business per capita	+
	Mobile phone penetration	+
	Number of legal units of information transmission, software and information technology services	+
	The proportion of persons employed in information software industry	+
	Number of authorized patent applications in China	+
	Number of domestic patent applications accepted	+
Industry digitization	Peking University Digital Financial Inclusion Index	+
	Proportion of enterprises with e-commerce trading activities	+
	E-commerce sales	+
	Number of websites per 100 businesses	+
	Added value of secondary and tertiary industries	+
	Input in scientific and technological innovation	+
	Express delivery volume	+

Mediating variable: Industrial structure (Struc). In this paper, the ratio of the output value of the tertiary industry to the output value of the secondary industry is used to represent the level of industrial structure.

Control variables: Regional economic development level (Pgdp), measured by regional per capita output level, and logarithmic data processing; Government intervention level (Govern), measured by local fiscal expenditure as a share of GDP; The level of industrialization (Industr), represented by the proportion of the added value of the secondary industry to the gross regional product; The level of urbanization (Urbani), which is represented by the proportion of urban population in the total population of the region; Trade openness (Open) is represented by the ratio of the total volume of imports and exports in the region to the gross regional product (GDP), and the data are treated logarithmically.

3.3. Model Setting

3.3.1. Baseline Regression Model Setting

$$Cxrhfz_{it} = \alpha_0 + Digi_{it} + \sum \text{control} + \delta_t + \mu_i + \varepsilon_{it} \tag{1}$$

In the above formula, $Cxrhfz_{it}$ and $Digi_{it}$ respectively represent the urban-rural integration development level and digitization level of the province in t year i; $\sum \text{control}$ represents the control variable; δ_t indicates the time fixed effect; μ_i represents individual fixed effect; ε_{it} denotes the term of random perturbation.

3.3.2. Intermediary Effect Model Setting

In this paper, the following intermediary effect model is set to test the impact path and effect of digital economy on urban-rural integration and development through technological progress. The specific model is set as follows:

$$\text{Struc} = \beta_0 + \beta_1 \text{Digi} + \sum \text{control} + \delta_t + \mu_i + \varepsilon_{it} \tag{2}$$

$$\text{Cxrhfz} = \gamma_0 + \gamma_1 \text{Digi} + \gamma_2 \text{Tech} + \sum \text{control} + \delta_t + \mu_i + \varepsilon_{it} \tag{3}$$

Where, Struc is the intermediary variable, β_1 , γ_1 and γ_2 represent the correlation coefficient, β_0 and γ_0 represent the intercept term.

4. Empirical Results Analysis

4.1. Analysis of Benchmark Regression Results

Table 4. Benchmark regression of digital economy on urban-rural integrated development

	(1)	(3)
	Cxrhfz	Cxrhfz
Digi	0.274***	0.284***
	(0.000)	(0.000)
lnPgdp		0.041***
		(0.000)
Govern		0.153*
		(0.065)
Industr		-0.009
		(0.744)
Urbani		0.003***
		(0.000)
lnOpen		0.005**
		(0.036)
_cons	0.258***	-0.360***
	(0.000)	(0.000)
id	YES	YES
year	YES	YES
N	403	403

This study empirically analyzes the impact of digital economy on the urban-rural integration development by constructing different fixed-effect models, and the results are shown in Table 1. Model (1) is a fixed-effect model without adding control variables. The results show that the coefficient of digital economy is 0.274, and it is significant at 1% level, indicating that digital economy has a significant promoting effect on urban-rural integration development. In model (2), after the addition of control variables, the coefficient of digital economy becomes 0.284, which still maintains the significance at 1% level, indicating that the model results are robust. In addition, among the control variables, government intervention, urbanization level, economic development level and opening to the outside world all have a significant positive impact on the urban-rural integration development, while industrialization level has a negative impact. Therefore, hypothesis 1 can be verified, that is, digital economy has a significant promoting effect on urban-rural integration.

4.2. Analysis of Regression Results of Intermediary Effect

Table 5. Analysis results of intermediary effects of technological progress

	(1)	(2)	(3)
	cxrhfz	struc	cxrhfz
digi	0.277*** (0.000)	0.468** (0.024)	0.277*** (0.000)
struc			0.016*** (0.001)
lnpgdp	0.038*** (0.000)	0.702*** (0.000)	0.050*** (0.000)
govern	0.118 (0.164)	-0.169 (0.839)	0.134 (0.109)
industr	-0.026 (0.364)	-6.314*** (0.000)	-0.121*** (0.003)
urbani	0.003*** (0.000)	-0.026*** (0.000)	0.002*** (0.000)
lnopen	0.003 (0.119)	-0.002 (0.935)	0.003 (0.159)
_cons	-0.297*** (0.003)	-2.059** (0.048)	-0.320*** (0.001)
id	YES	YES	YES
year	YES	YES	YES
N	372	372	372

Further research on the intermediary role of industrial structure (Struc) in the digital economy's promotion of urban-rural integration and development, and the results are shown in Table 5. Model (1) shows that the direct effect of digital economy on urban-rural integrated development is 0.277, and is significant at 1% level, indicating that digital economy can significantly promote urban-rural integrated development. Model (2) tested the impact of the digital economy on the industrial structure, and the results showed that the coefficient was 0.468, and it was significant at 1% level, indicating that the digital economy had a significant role in promoting technological progress. Model (3) After adding the industrial structure variable, the coefficient of digital economy still maintains the significance at 1% level, while the coefficient of industrial structure on the urban-rural integration development is 0.061, and is significant at 1% level. This result indicates that the industrial structure plays a partial mediating role in the process of digital economy promoting urban-rural integrated development. In addition, among the control variables, the level of urbanization (Urbani) and the level of economic development (lnPgdp) both have significant positive effects on the urban-rural integration development. Therefore, hypothesis 2 can be verified that the digital economy not only directly promotes the urban-rural integrated development, but also indirectly promotes the urban-rural integrated development through the intermediary role of industrial structure.

4.3. Robustness Analysis

In order to further verify the reliability of the model results, this paper adopts two methods of one-stage lag of explanatory variables and reduction of sample time range to conduct robustness analysis of the model, and the results are shown in Table 6.

Table 6. Robustness analysis results

	(1)	(1)
	cxrhfz	cxrhfz
digi	0.267***	0.271***
	(0.000)	(0.000)
lnpgdp	0.037***	0.040***
	(0.000)	(0.000)
govern	0.103	0.143*
	(0.217)	(0.085)
industr	-0.070**	-0.068**
	(0.012)	(0.016)
urbani	0.003***	0.003***
	(0.000)	(0.000)
lnopen	0.004*	0.005**
	(0.051)	(0.017)
_cons	-0.260***	-0.300***
	(0.008)	(0.002)
id	YES	YES
year	YES	YES
N	341	341

Model (1) adopts a shortened sample time range, and the result shows that the coefficient of digital economy is 0.267, which still maintains the significance at 1% level, which verifies the reliability of the benchmark result and indicates that the digital economy has a steady promoting effect on the urban-rural integration development. In model (2), the explanatory variable lags the regression result for one period, where the coefficient of digital economy is 0.271, which is significant at 1% level, indicating that the promotion effect of digital economy on urban-rural integration development has a time continuity.

5. Conclusion and Suggestions

Through a systematic empirical analysis of the panel data of 31 provinces (autonomous regions and municipalities directly under the Central Government) across the country, this study proves that the digital economy has a significant role in promoting urban-rural integration and development, and reveals its mechanism of action and regional differences. The results show that the digital economy not only directly promotes the integrated development of urban and rural areas, but also plays an indirect role through the intermediary channel of industrial structure.

Based on these findings, this paper puts forward the following suggestions: (1) Take the construction of digital infrastructure as an important project to promote the integrated development of urban and rural areas, and pay attention to the formulation of regional differentiated development strategies. (2) Attach great importance to the key role of upgrading the industrial structure, and realize the integrated development of urban and rural areas by adjusting the industrial structure.

References

- [1] Guo Feng, Wang Jingyi, Wang Fang, et al. Measuring the development of digital inclusive finance in China: index compilation and spatial characteristics [J]. *Economics (Quarterly)*, 2020,19(4): 1401-1418.

-
- [2] Han Jun. Research on China's Rural Revitalization Strategy in the New Era [M]. Beijing: People's Publishing House, 2021.
- [3] Czernich N, Falck O, Kretschmer T, et al. Broadband infrastructure and economic growth[J]. The Economic Journal, 2011, 121(552): 505-532.
- [4] Goldfarb A, Tucker C. Digital economics [J]. Journal of Economic Literature, 2019, 57(1): 3-43.
- [5] Cai Fang. Economic growth and structural change in Digital Economy era [J]. Economic Research Journal, 2023, 58(1): 4-20.
- [6] Lu Ming, Li Pengfei. Digital transformation and urban-rural income gap [J]. Management World, 2020, 36(12): 76-94.
- [7] Shao Yingying, Hua Junguo, Li Bingbing. Research on the Enabling Effect and Mechanism of Digital Economy on Urban-Rural Integrated Development [J]. Research on Industrial Modernization, 2024,45(03):477-487.
- [8] Li X. The impact of digital inclusive finance on Urban-Rural integrated development and its transmission mechanism [J]. Anhui Agricultural Sciences,2024,52 (10) : 206-215.
- [9] Wu Jianhui, Guo Yongxin. Digital Economy Boosting new-type urbanization: Based on spatial Durbin model and threshold model [J]. Resource Development and Market, 2019,40(09):1350-1361.