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Research on the impact of digital economy on urban-rural integrated development under the background of rural revitalization: Taking the Yangtze River Economic Belt as an example

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Abstract

The Yangtze River Economic Belt (YERB) is a key regional economic belt in China. Urban-rural integration plays a crucial role in its economic development. This project, taking the YERB as a case study, conducted field research and collected data from nine provinces and two municipalities within the YERB over the ten years from 2014 to 2023. The data were analyzed and, from a general systems theory perspective, the theoretical mechanisms by which the digital economy influences urban-rural relations were explored. The YERB digital economy and urban-rural integration development indices were calculated using entropy weighting and principal component analysis, respectively, and empirically validated. The results show that the digital economy significantly promotes rural industrial development, with significant regional variations; urban-rural integration significantly promotes rural industrial development, with significant regional heterogeneity; and that industrial restructuring plays a positive regulatory role in the digital economy and urban-rural integration promoting rural industrial development. To this end, we should deepen the impact of the digital economy on rural industrial development, fully strengthen the collective economy, enhance the role of urban-rural integration in promoting common prosperity, and promote the development of rural areas through urban development. Furthermore, we should closely link the support provided by industrial upgrading to rural development and promote the aggregation of key factors.

Keywords

Digital economy, Rural revitalization, Urban-rural integration, Entropy weight method, Principal component analysis.

1. Introduction

On the premise that national policies support the development of the digital economy and promote the process of urban-rural integration development, based on the relevant research done by predecessors and taking the relevant data of the Yangtze River Economic Belt as the basis, this paper analyzes the level of digital economic development and urban-rural integration development in the Yangtze River Economic Belt, as well as the impact of the digital economy in the Yangtze River Economic Belt on the level of urban-rural integration. The research conclusions have certain reference significance for analyzing the internal mechanism of the digital economy's impact on urban-rural integration development, and have certain auxiliary value for measuring the current status of digital economic development and urban-rural integration in the Yangtze River Economic Belt and formulating relevant policies.

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2. Literature review:

2.1. Research on the digital economy

The digital economy has a promoting effect on regional economic growth. Ilhan O. & Sana U. (2022) pointed out that by using digital inclusive financial tools, the digital economy has enhanced financial inclusion, which not only helps capital providers to provide financial services to consumers in a timely manner, but also promotes the development of financial markets, enriches financial products and services, and thus improves the level of regional economic development [9] . Shi Dan et al. (2022) analyzed the mediating effects of financial efficiency and capital mismatch on the digital economy in improving the quality of economic development, and conducted an empirical test using provincial panel data [1] . Lu Yuxiu (2021) proposed that urban innovation, market potential and industrial agglomeration are the transmission mechanisms for the digital economy to improve the quality of urban economic development, and the size of the city will also affect the effect of the digital economy on local economic development. The larger the city, the stronger the promotion effect, but the spatial effect of the digital economy in small cities is more obvious [2] . While the digital economy can provide momentum for regional economic growth, there are differences in the growth effect of the digital economy in different regions. Lechman E. (2022) believes that the digital economy is an important driving force for poverty alleviation in developing economies. Digitalization affects poverty reduction through income and education transfers and reducing labor market vulnerability, and it is recommended that the government must regard information and communication technology as a key factor in the digital economy development strategy [10] . Scientific digital economy measurement is a prerequisite for empirical analysis of digital economy issues. In addition to the comprehensive digital economy index released by official agencies (such as the DEI index of the China Academy of Information and Communications Technology) , domestic scholars have established various measurement and evaluation indicators based on different classification methods. Liu Fang et al. (2019) used a composite method of statistical indicators plus regression analysis to measure the basic industries related to the digital economy and the integration of the digital economy with other industries [3] .

2.2. Research on urban and rural development

Domestic research is mostly based on the Marxist idea of urban-rural relations. The mainstream view is that urban-rural development will move from urban-rural separation to urban-rural integration as China's urban-rural construction practice advances. Liu Shouying et al. (2022) believed that urban-rural integration means that the urban-rural research paradigm has shifted from urban-rural dichotomy to urban-rural continuum. They believed that urban-rural integration includes four aspects: the two-way flow of urban and rural population, the spatial integration of urban and rural land use, the integration of rural non-agriculturalization and the convergence of urban and rural industrial structures, and the integration of urban and rural residents' cognitive concepts [4] . K. Lynch (2005) summarized the functions of the five "flows" of food, resources, population, concepts, and capital between urban and rural areas in developing countries, and proposed the concept of "urban-rural dynamics". He also emphasized that the complexity of urban-rural relations should be analyzed from the perspectives of "livelihood strategy" and "resource allocation" [11] . Liu Minghui et al. (2019) pointed out that the mismatch of urban and rural factors is one of the key factors hindering the development of urban-rural integration. Among them, the role of population and land factor integration in promoting urban-rural integration is increasing marginally, while the role of capital factor integration in promoting urban-rural integration is decreasing marginally [5] . Based on the "flow space" theory, Zhou Jianing et al. (2020) analyzed the driving role and spatial pattern of urban and rural population, commodity, capital, and information flows on urban-rural

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integrated development, and found that the spatial network pattern of human flow and capital flow is relatively dense and balanced, while the spatial network pattern of commodity flow and information shows a "core-spoke" characteristic [6].

2.3. Research on the digital economy and urban-rural integrated development

As the digital economy penetrates into all areas of production and life, the research on the impact of the digital economy on urban-rural integration and development is also increasing at home and abroad. Starting from the production of small and medium-sized enterprises in rural areas, the urban-rural income gap, the urban-rural digital divide and other aspects, the impact of the digital economy on urban-rural integration and development has been studied. Thita M. Mazya (2023) pointed out that the digital economy has improved the lives and well-being of Indonesian farmers. The digitization of public services and the improvement of digital technology requirements for entrepreneurs play an important regulatory role in the impact of the digital economy on urban-rural integration and development [12]. Chen Xinxin et al. (2022) pointed out that the digital economy directly narrows the urban-rural gap by integrating urban and rural markets and modular division of labor, while the agglomeration economy indirectly narrows the urban-rural gap by reconfiguring the labor force [7]. Zhou De et al. (2021) believe that the digital economy can comprehensively improve the quality of urban-rural integration. It can use digital technologies such as big data and the Internet of Things to break the spatial boundaries between urban and rural areas, reduce market information asymmetry, guide the flow of urban factor resources to rural areas, optimize the allocation of urban and rural factors, and weaken the physical distance between urban and rural areas to solve the dilemma of urban-rural market segmentation and achieve urban-rural division of labor and cooperation [8].

2.4. Literature Summary

Through the above analysis, it is not difficult to find that the current research on the impact of the digital economy on urban-rural integration focuses on the impact of the digital economy on a single level of urban-rural integration from the perspective of either the digital economy or urban-rural integration. There are few systematic and holistic studies on the impact of the digital economy on urban-rural integration. Based on existing relevant research at home and abroad, this project establishes a general systems theory research framework to analyze the impact of the digital economy on the development of urban-rural integration. It considers the comprehensive influence of digital economic infrastructure, industrial development, and cultural environment on the three major structures of urban-rural economic integration, social integration, and ecological integration. Using relevant data from the Yangtze River Economic Belt, it constructs evaluation index systems for the digital economy and urban-rural integration development, and empirically tests the systematic and comprehensive impact of the digital economy on the development of urban-rural integration in the Yangtze River Economic Belt.

3. Theoretical Analysis and Research Hypotheses

The digital economy, supported by digital technology, is deeply embedded in all aspects of economic development, social management, and public life, profoundly influencing economic and social development. Driven by the digital economy, rural industries are gradually transforming from traditional industries to digitalization, informatization, and intelligence, thereby continuously improving production, operation, and management efficiency. Through the intermediary effect of efficiency transformation, the digital economy promotes the high-quality development of rural industries and promotes common prosperity among different regions and different classes. The widespread application of information such as Internet technology can effectively reduce transaction costs. The digital economy promotes intelligent communication, compensates for information asymmetry, and eliminates the time difference

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in obtaining information between urban and rural areas, thereby promoting the development of rural industries. Urban-rural integration has led to the widespread use of e-commerce platforms, promoted resource integration and the improvement of agricultural technology innovation levels, and thus promoted the integrated development of rural industries; urban-rural integration has led to the widespread application of digital technologies, making it possible to query the quality of agricultural products and trace their sources, enhancing the integrity of agricultural product information, and thus promoting the development of rural industries. Based on this, this paper proposes the following hypotheses:

Hypothesis 1: The digital economy and urban-rural integration have a promoting effect on the development of rural industries. The Yangtze River Economic Belt spans 11 provinces (municipalities), and each province (municipality) is at a different level of development. There are significant differences in the development levels of various industries and sectors in different regions. In terms of the level of high-quality development of rural industries, there are obvious differences in the growth rates of different provinces (municipalities). Rural industrial development is the result of the influence of comprehensive factors. The role of the digital economy and urban-rural integration also depends on the level of regional development itself. In high-level regions, the digital economy, urban-rural integration and rural industrial development have formed a trend of mutual integration. According to the law of diminishing marginal effects, their impact may not be significant or the impact effect may be small. In regions with a low overall development level, the digital economy, urban-rural integration and rural industrial development are all at a low level of development. The impact of the digital economy and urban-rural integration on rural industrial development is bound to be significant. In other words, in different regions, due to different overall development levels, the impact of the digital economy and urban-rural integration on rural industrial development may also be different. Based on this, this paper proposes the following hypothesis:

Hypothesis 2: There is regional heterogeneity in the role of digital economy and urban-rural integration in promoting the development of rural industries. Digitalization has played a great role in promoting the transformation of rural industries [18] . Urban-rural integration has brought urban civilization to the countryside, improved the cultural environment of the countryside, and enhanced the political quality of farmers. In rural management, villagers have shifted from instrumental participation to value participation. With the improvement of the political quality of rural people, the modernization and legalization of the rural industrial organization governance system has been continuously improved, which has contributed to the realization of the goal of high-quality development of rural industries. Driven by urban-rural integration, the level of rural industrial transformation and upgrading has been continuously improved, thereby continuously promoting the high-quality development of rural industries. Moreover, the more developed the region, the more significant the effect is. The reason is that the level of industrial structure upgrading in different regions is different. Therefore, whether it is the digital economy or urban-rural integration, its effect on rural industries will inevitably promote the upgrading of industrial structure. Based on this, this paper proposes the following hypothesis:

Hypothesis 3: Among the impacts of digital economy and urban-rural integration on rural industrial development, industrial structure upgrading plays a regulatory role.

4. Research design

4.1. Construction of indicator system

4.1.1. Variable selection

(1) Explained variables. Given the purpose of this study, the explained variable is set as rural industrial development (RI). Referring to relevant literature [23, 24] and combining the

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characteristics of rural industrial development, this paper constructs an index system consisting of six specific indicators to measure the level of rural industrial development from the two dimensions of rural industrial output and rural industrial expansion. Among them, rural industrial output reflects the output efficiency of the rural primary industry, and rural industrial expansion reflects the secondary and tertiary industries and their development potential. The specific composition of the index system is shown in Table 1.

Table 1Rural Development Industry Index System

Dimension layer	Indicator layer	Calculation method	unit	property	Weight
Rural industrial output	Rural per capita output value	Primary industry output value/rural population	Yuan/person	+	0.0606
	Agricultural machinery level	Total agricultural machinery power/total population	kWh/person	+	0.0820
	Level of primary industry development	Primary industry added value/total output value	%	-	0.0910
	Industrial Development Level	Secondary industry + tertiary industry/agricultural population	%	+	0.5073
Rural industry expansion	Software business revenue	Non-farm payrolls	10,000 people	+	0.182
	Basic education level	Number of students in primary and secondary schools/total number of students	%	+	0.0810

(2) Core explanatory variables. The core explanatory variables are set as digital economy (DE) and urban-rural integration (Uri). Regarding the digital economy, according to the general evaluation method and referring to existing research [25] , related industries with digital technology as the core are selected as measurement indicators, as shown in Table 2 for details.

Table 2Digital economy evaluation index system

Indicator layer	unit	property	Weight
Number of mobile phone users	household	+	0.1694
Number of Internet broadband access users	household	+	0.1516
Total telecommunications business volume	100 million yuan	+	0.1650
Number of employees in core industries of the digital economy	people	+	0.1953
Number of connected enterprises	Home	+	0.1901
Digital Financial Inclusion Index	-	+	0.1286

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Regarding urban-rural integration, referring to existing research [25] , an indicator system consisting of four dimensions: spatial level, economic integration, social integration, and ecological integration is constructed, as shown in Table 3.

Table 3Evaluation system of urban-rural integration level

Dimension layer	Indicator layer	Calculation method	unit	property	Weight
Space Level	Population urbanization	Urban population/total population	%	+	0.0770
	Land urbanization	Built-up area/jurisdiction area	%	+	0.2163
	Traffic level	Road mileage/land area	km/km^2	+	0.0610
Economic integration	Industrial Development Level	Primary industry/secondary industry + tertiary industry	%	-	0.0402
	Work-to-income ratio	Urban per capita/rural per capita	%	+	0.0646
	binary log ratio	Primary industry/secondary industry + tertiary industry (per capita output value)	%	-	0.0539
social integration	Urban and rural cultural and educational expenditures	Urban cultural and educational expenditure/Rural cultural and educational expenditure	%	-	0.0718
	10,000-person medical institution bed and bathroom	Urban/Rural	%	-	0.04432
	Minimum living standard	Urban population/rural population	%	-	0.2824
Ecological integration	forest coverage	Forest area/jurisdiction area	%	+	0.0506
	Park green space level	Per capita park green space area	square meters/person	+	0.0389

(3) Control variables. Rural industrial development reflects both the resource endowment of the village and the level of rural management, and is the result of the combined influence of multiple factors. Based on the importance of factors that may affect rural industrial development, five indicators, including financial structure (Fs), population density (Pd), technological market environment (Tme), technological innovation (Ti), and marketization degree (Ml), were selected as control variables.

Table 4Control variable names and measurement methods

name	symbol	Measurement method or source	unit
Financial structure	Fs	Year-end deposit balance/loan balance	%
population density	Pd	Number of registered residents/area at the end of the year	People/square kilometer
Technology market environment	Tme	Amount of results/GDP	%
Technological innovation	Ti	Number of three types of patent applications	item
Degree of marketization	Ml	From the "China Provincial Marketization Index Report"	-

4.1.2. Data Source and Description

(1) Data Source and Processing . This paper takes the 11 provinces (municipalities) in the Yangtze River Economic Belt as the research object, and the research period is from 2014 to

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2023. The degree of marketization comes from the "China Provincial Marketization Index Report", and other data are mainly from the website of the National Bureau of Statistics. This paper uses Stata 16.0 software to apply the entropy method to process the core explanatory variables and the explained variables to obtain the final values of the variables.

(2) Basic eigenvalues of variables. The basic eigenvalues of each variable are shown in Table 5. As can be seen from the results in Table 5, the standard deviation of rural industrial development level is 0.0876, which is relatively small, indicating that the level of rural industrial development in the Yangtze River Economic Belt is relatively close. However, the standard deviations of technological innovation, financial structure, and technological market environment are relatively large, indicating that there are large differences in technological innovation, financial structure, and technological market environment among different provinces (cities) in the Yangtze River Economic Belt, resulting in uneven development.

Table 5Descriptive statistics of variables

variable	symbol	Observation	mean	Standard deviation	Minimum	Maximum
Rural industrial development	RI	132	0.3278	0.0876	0.2015	0.5783
Digital Economy	DE	132	0.3424	0.2737	0.0068	0.9584
Urban-rural integration	Uri	132	0.2877	0.135	0.1719	0.7611
Financial structure	Fs	132	1.2904	0.2235	0.7214	1.9435
population density	Pd	132	7.9212	0.2721	7.4622	8.4809
Technology market environment	Tme	132	1.29	1.2891	0.1167	8.3023
Technological innovation	Ti	132	116824	144599.2	7150	752000
Degree of marketization	Ml	132	8.888	1.7785	4.138	12.864

4.2. Model Setting

4.2.1. Fixed Effects Model

Construct a fixed-effect model with digital economy (DE) and urban-rural integration (Uri) as core explanatory variables and rural industrial development (RI) as the explained variable:

$$RI_{i,t} = \alpha_0 + \alpha_1 DE_{i,t} + \alpha_2 Uri_{i,t} + \alpha_3 Col_{i,t} + Province_i + Year_t + \varepsilon_{i,t} \quad (1)$$

In the above formula, RIi , t represents the rural industrial development in province i during period t, DEi , t represents the digital economy in province i during period t , Urii , t represents the level of urban - rural integration in province i during period t, and Coli , t represents the control variables for financial structure (Fs), population density (Pd) , technological market environment (Tme), technological innovation (Ti), and marketization degree (Ml) in province i

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during period t . αi represents the coefficient to be estimated, Province i represents the individual fixed effect, Year t represents the time fixed effect, and εi ,t is the error term.

2. Moderation Effect Model

In order to test the moderating role of industrial structure upgrading (Up) in the impact of digital economy (DE) on rural industrial development, a moderating model is constructed with industrial structure upgrading as the moderating variable as follows:

$$RI_{i,t} = \gamma_0 + \gamma_1 DE_{i,t} + \gamma_2 Up1_{i,t} + \gamma_3 DE_{i,t} \times Up1_{i,t} + \alpha\gamma_x \sum C\,ol_{i,t} + Province_i + Year_t + \varepsilon_{i,t} \quad (2)$$

$$RI_{i,t} = \gamma_0 + \gamma_1 Uri_{i,t} + \gamma_2 Up2_{i,t} + \gamma_3 Uri_{i,t} \times Up2_{i,t} + \gamma_x \sum C\,ol_{i,t} + Province_i + Year_t + \varepsilon_{i,t} \quad (3)$$

In the above formula, RI is the development of rural industries, DE is the digital economy, Uri is the level of urban-rural integration, and Up is the level of industrial structure upgrading. The level of industrial structure upgrading is the sum of the GDP of the secondary industry and the GDP of the tertiary industry as a percentage of GDP. The proportion of GDP in the tertiary industry to GDP in the secondary industry (Up1) and the proportion of GDP in the tertiary industry to GDP in the secondary industry (Up2) are measured and introduced into the model as moderating variables, and two regression tests are performed. If the coefficient γ1 in both Equations (2) and (3) is significant, and the interaction coefficients between industrial structure upgrading (Up) and the digital economy (DE) and urban-rural integration (Uri) in both equations are significant, then it indicates that the digital economy and urban-rural integration have played a moderating role in influencing rural industrial development, and industrial structure upgrading has played a moderating role.

5. Empirical Testing and Analysis

5.1. Stationarity Test

This paper uses four common test methods, including LLC and ADF , to test the stationarity of the core variables. The test results are shown in Table 6. As shown in Table 6, rural industrial development (RI) and digital economy (DE) failed the HT and Fisher-PP tests, and urban-rural integration (Uri) failed the Fisher-PP test. Therefore, the variables were first-differenced and then tested. The test results show that the core variables D_RI, D_DE, and D_Uri after differentiation all passed the 1% significance test, indicating that the data are stationary and meet the conditions for further empirical testing .

Table 6Stationarity test results of core variables

variable	LLC	IPS	HT	Fisher-PP
RI	-15.7917*	-1.4000 *	0.4689	12.0864
OF	-6.2092*	-1.8281**	0.4994	22.1315
Uri	-4.0707*	-2.2063**	0.3313*	15,416
D_RI	-12.1114 *	-4.0051*	0.1699*	78,5261 *
D_DE	-3.4431*	-5.0865*	-0.0059*	137.0037 *
D_Uri	-5.9311*	-4.5353*	-0.1970 *	85.5828*

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5.2. Fixed effect test

To analyze the impact of the digital economy and urban-rural integration on rural industrial development, this paper conducts mixed regression (Model 1) and double-fixed-effect regression (Model 2) to examine the impact of the digital economy (DE) and urban-rural integration (Uri) on rural industrial development (RI). To eliminate possible intra-group autocorrelation, contemporaneous correlation, and inter-group heteroskedasticity, panel PCSE estimation (Model 3) and FGLS estimation (Model 4) are performed to obtain the final model estimation results. The specific regression estimation results are shown in Table 7.

The test results in Table 7 show that in the mixed regression (Model 1), the core explanatory variable, the digital economy, has a positive impact on rural industrial development, passing the 1% significance level. The impact of urban-rural integration on rural industrial development is also positive, passing the 1% significance level. Therefore, a double-fixed-effects test (Model 2) was conducted after fixing time and individuals. The test results show that the impact coefficient of the digital economy on rural industrial development is negative, passing the 1% significance level, and the impact coefficient of urban-rural integration on rural industrial development is negative, passing the 10% significance level. However, tests in the mixed regression with both time and individual fixed conditions yielded opposite results, indicating the presence of omitted variables. Therefore, further, more precise testing is necessary.

To obtain more precise test results, we further tested the impact of the digital economy and urban-rural integration on rural industrial development using panel PCSE regression (Model 3) and panel FGLS regression (Model 4). The results show that the digital economy has a positive impact on rural industrial development, passing the 1% significance test in Models 3 and 4, respectively. The impact of urban-rural integration on rural industrial development is also positive, passing the 1% significance test in both Models 3 and 4. The model estimation results indicate that the digital economy and urban-rural integration can significantly promote rural industrial development.

Table 7Specific results of model testing

variable	Explained variable (RI)			
	Model 1	Model 2	Model 3	Model 4
DE	0.1642 *** (0.020)	-0.2394 *** (0.078)	0.1309 *** (0.029)	0.1338 *** (0.011)
Uri	0.2846 *** (0.041)	-0.1181* (0.071)	0.1484 *** (0.052)	0.1383 *** (0.013)
Control variables	Controlled	Controlled	Controlled	Controlled
constant term	-0.3433 (0.132)	1.0983 *** (0.2175)	-0.146 (0.1049)	-0.1336 *** (0.034)
Observations	132	132	132	132
R^2	0.7854	0.9593	0.8417	—

5.3. Regional heterogeneity test

The Yangtze River Economic Belt spans 11 provinces and municipalities and can be divided into upstream, midstream, and downstream regions. These three regions possess significant differences in resource endowments and their digital economy development levels vary

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significantly. So, do the digital economy and urban-rural integration have the same impact on rural industrial development? To clarify this question, based on the demarcations of relevant national departments, the Yangtze River Economic Belt was further divided into the upstream region (Yunnan, Guizhou, Sichuan, and Chongqing); the midstream region (Hunan, Hubei, and Jiangxi); and the downstream region (Anhui, Zhejiang, Jiangsu, and Shanghai). The impact of the digital economy and urban-rural integration on rural industrial development in these different regions was examined separately. The results are shown in Table 8 .

Table 8Specific results of regional heterogeneity test

variable	Upstream RI		Midstream RI		Downstream RI	
	Model 5	Model 6	Model 5	Model 6	Model 5	Model 6
DE	0.3026 ** * (-0.041)	0.3276 *** (-0.0351)	0.3641 ** * (-0.086)	0.3211 ** * (-0.077)	0.1132* (-0.062)	0.059 6 (-0.05)
Uri	0.117 (-0.074)	0.1874 ** * (-0.056)	0.2264** (-0.106)	0.2694 ** * (-0.093)	0.0464 (-0.063)	0.0721 (-0.044)
Control variables	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
constant term	0.3415 ** * (-0.129)	0.4252 ** * (0.097)	-0.4693* (0.243)	-0.4041* (0.217)	-2.0617*** （0.473）	-1.7195*** （0.372）
R^2	0.8688	—	0.9093	—	0.8919	—

Table 8 show that in the upper reaches of the Yangtze River Economic Belt, the digital economy exhibits a significant positive impact on rural industrial development in both Models 5 and 6, with coefficients of 0.3026 and 0.3276, respectively, and significance at the 1% level. The impact of urban-rural integration on rural industrial development is insignificant in Model 5 but is significantly positive at the 1% level in Model 6, with a coefficient of 0.1874. In the middle reaches of the Yangtze River Economic Belt, the digital economy exhibits a significant positive impact on rural industrial development in both Models 5 and 6, with coefficients of 0.3641 and 0.3211, respectively, and significance at the 1% level. The impact of urban-rural integration on rural industrial development is significant and positive in both Models 5 and 6, with coefficients of 0.2264 and 0.2694, respectively, at the 5% and 1% levels, respectively. In the lower reaches of the Yangtze River Economic Belt, the digital economy's impact on rural industrial development is significant and positive in Model 5 but insignificant in Model 6. The impact of urban-rural integration on rural industrial development is insignificant in both Models 5 and 6. This is because the digital economy and urban-rural integration are already highly developed in the lower reaches of the Yangtze River Economic Belt, and rural areas have become blurred within this integrated urban-rural development. Therefore, the digital economy and urban-rural integration are no longer key factors influencing rural industrial development.

6. Conclusions and Recommendations

6.1. Research conclusions

Based on statistical data from 11 provinces and municipalities in the Yangtze River Economic Belt from 2014 to 2023, this paper constructs a comprehensive evaluation index system for rural industrial development, the digital economy, and urban-rural integration. The comprehensive evaluation index is calculated using the entropy method. Finally, using mixed regression models, time- and individual-fixed-effect models, and moderation models, we empirically test the impact of rural industrial development, the digital economy on rural

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industrial development, and the moderating effect of industrial structure. Regional heterogeneity is also tested in the upper, middle, and lower reaches of the Yangtze River Economic Belt. The paper concludes that: First, the digital economy can significantly promote rural industrial development, but its impact exhibits significant regional variations. The digital economy is deeply embedded in all aspects of rural industrial development, promoting the transformation of traditional agriculture to smart agriculture, thereby stimulating the potential for agricultural industrial development. Empirical results show that the digital economy has a significant positive impact on rural industrial development in the Yangtze River Economic Belt. However, due to the different stages of rural industrial development in different regions, the digital economy's impact on rural industrial development varies. The impact is significant in the upper and middle reaches of the Yangtze River Economic Belt, but not in the lower reaches.

Second, urban-rural integration can significantly boost rural industrial development, but its impact also exhibits significant regional heterogeneity. Urban-rural integration promotes the flow of urban and rural production factors, facilitating the upward movement of rural industries along the industrial chain. Therefore, it can boost rural industrial development. Due to significant differences in development levels across the Yangtze River Economic Belt, the impact varies. In the upper and middle reaches of the Yangtze River Economic Belt, where rural industrial development is relatively underdeveloped, urban-rural integration has significantly boosted rural industrial development. In the lower reaches of the Yangtze River Economic Belt, where urban-rural integration is already high and essentially integrated, the impact of urban-rural integration on rural industrial development is less pronounced.

Third, as the digital economy and urban-rural integration promote rural industrial development, industrial restructuring plays a positive regulatory role. In the development of the rural economy, the digital economy primarily provides technological support. Urban-rural integration accelerates the flow of production factors and promotes mutual support between urban and rural areas. However, the full impact of both the digital economy and urban-rural integration must be anchored in rural industrial development. The higher the level of industrial development, the larger the platform for the digital economy to function. Higher levels of industrial development inevitably lead to greater urban-rural integration and a more rational allocation of production factors. Therefore, industrial restructuring plays a positive regulatory role.

6.2. Policy recommendations

First, we must deepen the impact of the digital economy on rural industries and fully strengthen the collective economy. The digital economy is a crucial component of new productivity and the fundamental driving force behind rural industrial development. We must fully recognize the role of new productivity, centered on digital technology, and deepen the application of digital technology and other new productivity factors in rural industrial development. We must promote the integration of new productivity and rural industries, thereby driving the steady and healthy development of rural industries and continuously strengthening the collective economy, providing a strong driving force for rural industrial development.

Second, we must strengthen the role of urban-rural integration in promoting common prosperity and fully promote the strategy of cities leading rural development. my country's urbanization has entered a high-level stage, and urban-rural integration has achieved remarkable results in developed regions. However, the level of urban-rural integration varies greatly across regions, and imbalance and inadequacy have become a major challenge facing development. Therefore, we must enhance the level of urban-rural integration, strengthen its role in promoting common prosperity, and comprehensively promote the strategy of cities leading rural development to achieve common prosperity for all of society.

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Third, we must leverage the support provided by industrial upgrading for rural development and collaboratively promote the aggregation of production factors. The process of rural industrial development is a process of continuous industrial upgrading. We must cultivate and develop new productive forces, apply digital technologies to support rural industrial development, fully promote rural industrial upgrading, and collaboratively promote the aggregation of production factors in rural industries. This will continuously enhance urban-rural coordination and promote high-quality development of rural industries.

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