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Research Article

THE MECHANISM AND EMPIRICAL STUDY OF THE INTEGRATION OF DIGITAL ECONOMY AND REAL ECONOMY TO PROMOTE HIGH-QUALITY ECONOMIC DEVELOPMENT

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Abstract

With the development of technological revolution, the integration of digital economy and real economy (referred to as digital-real integration) has become an important engine to promote high-quality development of China's economy. By constructing the theoretical framework of digital-real integration affecting high-quality economic development, this paper uses the fixed effect and intermediary effect model to investigate its mechanism on the basis of using the entropy method to measure the development index of the two from 2014 to 2020 in China. The research show that digital-real integration has a double impact on high-quality economic development, one is the direct effect, which is manifested in the obvious heterogeneity between different regions and different economic levels, and the other is the indirect effect by influencing technological innovation, industrial structure upgrading and urbanization process. In this regard, this paper proposes countermeasures to promote digital-real integration from the aspects of top-level design, condition support and regional cooperation, in order to better promote high-quality economic development.

Keywords: High-quality economic development, Digital economy, Real economy, Integrated development, Mediating effect model.

INTRODUCTION

With the increasing desire of people for a better life, the quality of economic development has received great attention from all walks of life, and although China has entered the stage of high-quality development, it is facing the crisis of imbalance in the supply and demand structure of real economy, the lack of innovation capacity and the disconnect between real economy and virtual economy development (Liu, 2017). As an important support for the prosperity of the country, high-quality development of real economy is the key to achieve healthy and sustainable economic development. In the face of the plight of real economy that needs to be addressed urgently, some scholars believe that we should start by promoting the transformation and upgrading of economic and institutional structures (He, 2018). And in the rapid development of technological change and innovation, digital economy which has gradually developed from information economy, can efficiently adjust market structure and optimize operation mode, providing a strong impetus to solve operational problems of real economy and achieve high-quality economic development. Promoting the integration of digital economy and real economy has now become a new development direction for China.

LITERATURE REVIEW

Through combing the existing literature, it is found that the topic of high-quality economic development already has a good research foundation, and a lot of research has been conducted on it from the perspective of digital economy. Ning (2020) analyzed the mechanism based on several economic theories, such as quality management, in terms of quality, efficiency, and dynamics, and found that there is heterogeneity among regions in the promotion role played by digital economy through empirical tests. Yang *et al.* (2021) found that there are five paths to drive economic development in digital economy based on the analysis of histological perspective, among which strengthening industrial digitization is the most effective and feasible approach. Zhang *et al.* (2021) logically reasoned from macro, meso, and micro perspectives, and found through empirical studies that human capital enhancement and industrial structure upgrading can play a certain indirect promotion role. Hu *et al.* (2021) found that digital economy can promote high-quality economic development, but there is an "inverted U-shaped" marginal effect. Wang (2019) found that digital economy is more effective in promoting economic development through its penetration into traditional industries in the three levels of factor allocation, industrial upgrading, and quality of economic growth. As scholars continue to pay attention to the development of convergent digital economy and the proposal of digital-real integration, academics have also conducted relevant research on it. Jing and Sun (2019) argued that the integration of digital economy and traditional economy will become the mainstream trend of future economic development, and its integration development can not only optimize enterprise business processes, but also promote the improvement of traditional consumption and service models. Wang (2021) found that the impact of digital-real integration on high-quality economic development is essentially realized through digital transformation of industries, which can expand the overall effectiveness of economy through comprehensive optimization and model improvement. Kuang and Peng (2020) thought that traditional industries are influenced by digital economy, which accelerates the transformation of real economy to digitalization and forms a two-wheel drive model of digital-real integration development, which can influence the security of industrial chains and supply chains and the sustainable growth of foreign investment, and as well as stimulate consumption, investment, government spending, and

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increase employment and income. Ren and Chi (2022) explored from the theoretical mechanism, digital economy integrates innovative elements into real economy and uses new-generation technology to promote the comprehensive transformation of traditional industries, further promoting the division of labor and transformation of real economy and providing strong support for high-quality development. In summary, the academic community has made abundant research results on high-quality economic development based on digital economy perspective, both at the theoretical and empirical levels, and scholars have realized that the economic model of integration is more conducive to high-quality development in the research process. However, as far as the existing research is concerned, the discussion of digital-real integration on high-quality economic development is still at the theoretical level, and the quantitative analysis of its impact from the empirical perspective is still to be enriched. Therefore, based on the perspective of integration, this paper systematically analyzes the direct and indirect mechanisms of how digital-real integration contributes to high-quality economic development, and examines the transmission paths of technological innovation, industrial structure upgrading and urbanization process by using panel data of 30 provinces and cities in China from 2014 to 2020, in order to provide theoretical and practical support for promoting high-quality economic development.

THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

Direct impact mechanism of digital-real integration in promoting high-quality economic development

Digital-real integration has an impact on the whole society, the whole factor and the whole industry through mechanisms such as promoting facilitation services, improving resource allocation efficiency and reducing input costs, in order to promote high-quality economic development.

(1) Digital-real integration benefits the country and the people, and drives society forward.

Enhancing comprehensive national power and improving people's quality of life have become an important part of high-quality economic development. The use of data as a factor of production and input in many aspects of production, consumption and circulation has promoted the improvement of total factor productivity. The integration and penetration of digital technology into the industrial field makes the enterprises in the Matthew effect deep under the influence of digital economy have certain market development advantages and break the monopoly situation of the market. In addition, digital-real integration has changed people's way of life, and the wide application of digital technology has provided people with many convenient service models, such as smart home, digital government, intelligent medical care, etc. With the rapid development of China's Internet, the gradual coverage of information technology to rural areas has led to the digital development of rural areas, which has further narrowed the gap between urban and rural areas, thus contributing to the overall economic development in the direction of high quality.

(2) Digital-real integration speeds up and improves quality, and achieves efficient resource allocation.

Digital-real integration has gradually developed real economy from a supply-oriented economy of scale to a demand-led economy of scope. Due to geographical location and production equipment constraints, the production mode that could not obtain more demand information has been improved. Digital economy with its instantaneous and permeable characteristics, has found more market possibilities for the development of real economy, allowing resources in different fields to be efficiently docked and organically integrated, tapping into the added value of products and making full use of data and information, thus reducing the operational risks of enterprises and forming a more optimal way of resource allocation.

(3) Digital-real integration to reduce costs and consumption and pursue industrial ecological development.

With its precise and networked characteristics, digital economy allows accurate docking and control in the production process, grasps production usage in the production chain, reduces resource consumption and product defect rate, and promotes production quality improvement and green development. In addition, real economy is no longer restricted by time and space, publishing information through the network and looking for demand customers for transactions, reducing production costs and transaction costs throughout the process from production to sales. Along with the deep integration development, traditional industries will be impacted, and under the environment of continuous innovation and application of digital technology, new industries and new models derived will continuously enrich the content of the economic field and further optimize the economic structure system.
Based on the above analysis, the following hypotheses are proposed.

Hypothesis H1. Digital-real integration can effectively promote high-quality economic development.

Indirect impact mechanism of digital-real integration in promoting high-quality economic development

The huge potential bursting out from digital-real integration will promote high-quality economic development to achieve three major changes in power, efficiency and quality.

(1) Power change mechanism. The development of digital economy and digital-real integration has put forward high requirements for technology applications. As a category involving technology-intensive industries, digital economy places more emphasis on the mastery of technology and innovation, and high-quality development that coincides with the new development concept also puts the innovation element in an important position. The digital transformation of real economy requires penetration and use of digital technology, and the higher level of technological innovation, the deeper integration will be, which is more conducive to the precise development of business activities. As technology is influenced by R&D and the "learning by doing" effect, continuous progress will provide long-term momentum for economic development (Zhao *et al.,* 2015). Through the continuous improvement of technological innovation, the mastery of core technologies can further enhance China's comprehensive national power.

(2) Efficiency change mechanism. The continuous development of digital economy makes the digital industry gradually penetrate into other industries and promote the

digital transformation of industries. The mutual collaboration among industries can effectively improve the efficiency of resource allocation, strengthen the linkage between factors and make the industrial value chain develop towards high-end. At the same time, as the integration continues to deepen, the market competition in industrial development will intensify, and industries with backward technology will gradually be replaced by industries with strong technological capability and high innovation, and those industries with poor integration capability and solidified development mode will gradually withdraw from the market, prompting the transformation of industrial structure, and this change for the better will promote the upgrading of industrial structure and realize the structural growth of the economy.

(3) Quality change mechanism. Digital-real integration has changed the rough development mode of industry and enriched the demand of job market. The digital integration from production to consumption reduces resource consumption, cost input and environmental pollution to ease ecological pressure, solves the impact of environmental problems on the urbanization process, and further improves the quality of economic development (Chen and Chen,2018). At the same time, the application of digital technology has increased the demand for jobs in the information technology service industry, creating a platform employment model with high flexibility, which can effectively solve the job demand of those who are waiting for work, drive the employment rate in China, and obtain more employment opportunities for the rural population in urban development, which in turn accelerates the flow of rural population to cities, promotes the increase of residents' income, stimulates consumption, and accelerates the urbanization process.

Integrating the previous analysis, the hypothesis is proposed and the theoretical framework of this paper is constructed as shown in Figure 1.

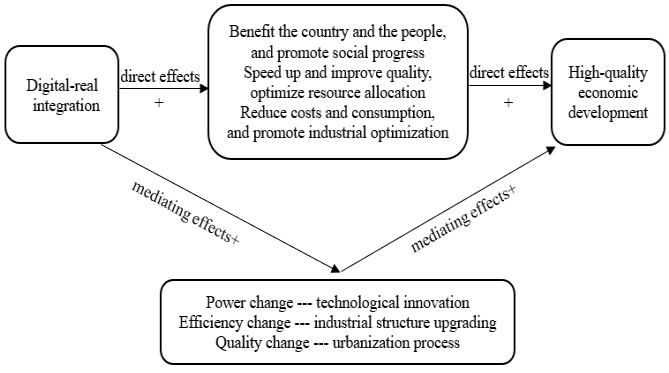

Figure 1. Theoretical framework

Hypothesis H2. Both digital-real integration and high-quality economic development will be affected by technological innovation, and the stronger technological innovation capability, the more obvious impact of digital-real integration on high-quality economic development.

Hypothesis H3. The upgrading of industrial structure is of great significance to economic development, and the more optimized its structure, the greater promotion of efficiency in the integration of high-quality economic development.

Hypothesis H4. Promoting urbanization process will become a necessary way for digital-real integration to promote high-quality economic development.

EMPIRCAL TESTING

Model Construction

Based on the theoreticalframework constructed in this paper, the basic models are set as:

$$Hqd_{it} = \alpha + \beta Dri_{it} + \mu Control_{it} + \delta_i + \gamma_i + \varepsilon_{it} \quad (1)$$

the equation (1) Hqd_{it} denotes the index of high-quality economic development, Dri_{it} is the index of digital-real integration development, $Control_{it}$ denotes a set of control variables, δ_i denotes the individual fixed effects, γ_i denotes the time fixed effects, and ε_{it} denotes the error term.

In addition to the direct effect of equation (1), there may be indirect effects through acting on other pathways. Therefore, this paper introduces a mediating effect model to explore its intermediate path of action. The mediating effect model is set as follows.

$$Hqd_{it} = \alpha_1 + cDri_{it} + \mu_1 Control_{it} + \delta_i + \gamma_i + \varepsilon_{i1} \quad (2)$$

$$M_{it} = \alpha_2 + aDri_{it} + \mu_2 Control_{it} + \delta_i + \gamma_i + \varepsilon_{i2} \quad (3)$$

$$Hqd_{it} = \alpha_3 + c'Dri_{it} + bM_{it} + \mu_3 Control_{it} + \delta_i + \gamma_i + \varepsilon_{i3} \quad (4)$$

where M_{it} indicates mediating variable, c' denotes the effect of the independent variable on the dependent variable in the presence of mediating variable, $a * b$ denotes the intermediate effect exerted by the mediating variable, and $c = c' + a * b$ denotes the total effect of the independent variable affecting the dependent variable.

Measurement of variables and description of data

(1) Explained variables (Hqd). At present, the assessment system of high-quality economic development has not yet been unified, but scholars have found that its meaning is highly compatible with China's new development concept (Song and Zhang, 2022). Therefore, this paper constructs an indicator evaluation system based on the new development concept, combining the internal and external factors of high-quality economic development (Song,2019), from six aspects: economic scale, innovation input, coordinated development, green ecology, openness to the outside world, and shared services (see Table 1).

(2) Explanatory variables (Dri). Digital-real integration is essentially the digital transformation of industries, whose main features are accelerated industrial transformation, penetration of industrial cooperation, and transformation of supply and demand patterns (Guo, 2020). In this paper, the development level of digital-real integration is measured from the digital development of three industries (see Table 2).

Table 1. High-quality economic development evaluation index system

Tier 1 Indicator	Tier 2 Indicator	Calculation Method	Attribute
Economic Operation	Economic Development	GDP per capita	+
	Economic Stability	Total retail sales of social consumer goods/GDP	+
		Number of registered unemployed	-
	Economic Performance	Total Factor Productivity	+
Innovation Capability	Innovation Input	R&D investment intensity	+
		Science and technology fee expenditure/GDP	+
	Innovation Output	Number of patent applications	+
		Amount of technology contract turnover/GDP	+
Coordinated Development	Urban-rural Coordination	Thiel Index of Disposable Income of Urban and Rural Residents	-
		Thiel index of final consumption of urban and rural residents	-
	Industry Coordination	Thiel index for the three industries	-
	Structural Coordination	Urban population/total population	+
Green Ecology	Ecological Civilization	Greening coverage of built-up areas	+
		Green space per capita	+
	Environmental Treatment	Household waste harmless treatment capacity	+
		Emissions of three wastes per unit of GDP	-
Open Development	Trade Exports	Imports and exports/GDP	+
	People to and from	Number of inbound overnight visitors received	+
	Foreign Investment	Number of foreign-invested enterprises registered at the end of the year	+
		Foreign Investment/GDP	+
Shared Services	Public Services	Number of beds in medical institutions per10,000 people	+
		Number of students enrolled in higher education per 100,000 people	+
	Benefit Guarantees	Road area per capita	+
		Public library holdings per capita	+

Table 2. Digital-real integration development evaluation index system

Tier 1 Indicator	Tier 2 Indicator	Attribute
Digitalization of the primary industry	Rural electricity consumption	-
	Total output value of agriculture, forestry, animal husbandry and fishery	+
	Rural broadband access users	+
Digitalization of the secondary industry	The ratio of new product sales to main business revenue	+
	Number of websites per 100 companies	+
	The ratio of information technology services to main business income	+
Digitalization of the tertiary industry	E-commerce sales	+
	The ratio of enterprises with e-commerce activities	+
	Courier revenue	+

Table 3. Descriptive statistics of variables

Variables	Symbols	Obs	Mean	Std	Min	Max
Explained variables	Hqd	210	0.301	0.148	0.111	0.706
Explanatory variables	Dri	210	0.167	0.114	0.028	0.693
Mediating variables	Create	210	118468.9	157494.9	1534	967204
	Indu	210	0.401	0.02	0.371	0.473
	City	210	0.61	0.112	0.4024	0.893
Control variables	Gov	210	0.268	0.113	0.119	0.753
	Human	210	9.332	0.892	7.514	12.681
	Market	210	0.604	0.132	0.353	0.868
	Env	210	34.668	37.662	0.854	309.838

(3) Mediating variables. Technological innovation is an important source of power in the new era, usually scholars use the number of patent applications or grants to measure it, considering the time-consuming process of granting, the number of domestic patent applications is chosen to indicate the level of technological innovation (Create). Industrial structure upgrading means the progression of industrial structure from low level to high level, so that the contribution share of secondary and tertiary industries in economic development increases. This paper includes all three industries in the scope of investigation, and uses the weighted sum of three industries to measure the upgrading of industrial structure (Indu). The level of urbanization is then measured by the percentage of urban population (City).

(4) Control variables. In order to more accurately measure the impact of digital-real integration on high-quality economic development, this paper selects some representative indicators as control variables from the literature on factors influencing high-quality development (Peng and Zhu,2020). The ratio of general government expenditure to GDP is used to measure the degree of government intervention (Gov). The level of human capital is measured by the level of education per capita (Human). The ratio of employment in urban non-state enterprises is used to measure the level of marketization (Market). And the ratio of investment in industrial pollution control to industrial value added is used to measure the level of environmental regulation (Env).

(5) Data description. Given the availability of data, this paper only selects data from the China Statistical Yearbook for the remaining 30 mainland provinces and cities except Tibet for the study. The descriptive results of each variable are shown in Table 3.

As can be seen from Table 3, the mean and the maximum values of digital-real integration and high-quality economic development indices calculated by the entropy method are widely different, indicating that digital-real integration and high-quality economic development in China are uneven, and there is still much room for improvement. Among the remaining variables, the standard deviation of the data of technological innovation and environmental regulation is large, so they are treated as logarithms to weaken the heteroskedasticityof the data and maintain the balance among the indicators. The VIF test was conducted for all variables, and their values were less than 3 (the mean value of VIF was 2), indicating that there was no multicollinearity among the variables and the next analysis could be conducted.

In order to understand more intuitively the trend of digital-real integration and high-quality economic development in China, the development trend is plotted according to the average value of regional development index in each year (see Figure 2).

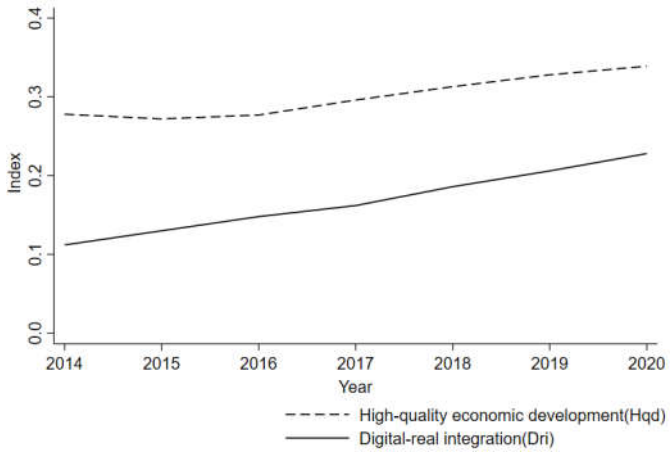

Figure 2. Development index from 2014 to 2020

As can be seen from Figure 2, the level of digital-real integration and high-quality economic development in China have some similarity, and both show a small fluctuation upward trend, so we can tentatively think that there is a correlation between them.

Analysis of basic regression results

The hausman test (P=.004<0.05) was performed on the panel data of 30 Chinese provinces and cities from 2014-2020 using Stata software, and a fixed-effects model controlling for heteroskedasticity robust standard errors was selected for the analysis, considering that the logit treatment could not completely eliminate the effect of heteroskedasticity. The basic regression estimates were obtained by introducing variables one by one (see Table 4).

From the results in Table 4, we know that with the increase of control variables, the regression coefficient of digital-real integration decreases continuously, and the impact performance is stable, and it is significantly positive in columns (1)-(5), which indicates that digital-real integration has a positive effect on high-quality economic development, which confirms the research hypothesis H1 proposed in this paper. In terms of control variables, all variables except government intervention and environmental regulation have positive effects on high-quality economic development, among which the positive effect of marketization level is the most obvious, indicating that the stronger the market economy is active, the more conducive to promoting the rational allocation of resources and free competition among enterprises, thus promoting high-quality economic development.

Table 4. Impacts of digital-real integration on high-quality economic development

	(1)	(2)	(3)	(4)	(5)
Variables	Hqd	Hqd	Hqd	Hqd	Hqd
Dri	0.339***	0.338***	0.23***	0.211***	0.185***
	(0.039)	(0.039)	(0.044)	(0.042)	(0.043)
Gov		-0.144	-0.106	-0.138	-0.116
		(0.107)	(0.102)	(0.097)	(0.096)
Human			0.052***	0.043***	0.036**
			(0.011)	(0.011)	(0.011)
Market				0.338***	0.296***
				(0.076)	(0.077)
Lnenv					-0.008**
					(0.003)
Constants	0.244***	0.283***	-0.191*	-0.307**	-0.189*
	(0.007)	(0.03)	(0.107)	(0.105)	(0.114)
Models	FE	FE	FE	FE	FE
N	210	210	210	210	210
R2	0.298	0.305	0.378	0.441	0.460

*Note: Standard errors are in parentheses; *** P < 0.01; ** P < 0.05; * P < 0.1.*

The higher level of human capital is conducive to improving the comprehensive quality of the nation and the subjective initiative played by people in the development is also enhanced. While the government's concern for green and sustainable development, enterprises have increased their expenditure on environmental pollution control, leading to a tilt in the internal investment field, which to a certain extent hinders high-quality economic development. Excessive government intervention in the market operation will increase the dependence of enterprises on the government, which is not conducive to the formation of a good competitive environment, and at the same time, the relevant policies introduced by the government will guide the direction of market development. Therefore, it is necessary to rationalize the relationship between the government and the market in economic development and clarify the role and status of the government in promoting high-quality economic development.

Analysis of mediating effect results

The mechanism of digital-real integration influencing high-quality economic development as described in the previous theoretical section is further tested by using the mediating effect model (see Table 5).

In Table 5, column (1) is the baseline regression result, and columns (2), (4) and (6) verify whether digital-real integration can accelerate technological innovation, industrial structure upgrading and urbanization process respectively. The results show that the regression coefficient of digital-real integration is significantly greater than 0 at the 1% level, indicating that the promotion of digital-real integration has a catalytic effect on technological innovation, industrial structure and urbanization development.

Table 5. Mechanism of action regression results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	Hqd	Lncreate	Hqd	Indu	Hqd	City	Hqd
Dri	0.185***	1.799***	0.122**	0.056***	0.106**	0.173***	0.034
	(0.043)	(0.373)	(0.043)	(0.009)	(0.045)	(0.031)	(0.036)
Gov	-0.116	0.434	-0.131	-0.01	-0.103	-0.078	-0.049
	(0.096)	(0.841)	(0.092)	(0.02)	(0.092)	(0.07)	(0.074)
Human	0.036**	0.587***	0.016	0.01***	0.022*	0.05***	-0.008
	(0.011)	(0.098)	(0.012)	(0.002)	(0.011)	(0.008)	(0.01)
Market	0.296***	1.02	0.261***	0.016	0.274***	0.222***	0.103*
	(0.077)	(0.673)	(0.074)	(0.016)	(0.074)	(0.056)	(0.062)
Lnenv	-0.008**	-0.168***	-0.002	-0.002**	-0.005	-0.008***	-0.001
	(0.003)	(0.028)	(0.003)	(0.001)	(0.003)	(0.002)	(0.003)
Lncreate			0.035***				
			(0.008)				
Indu					1.396***		
					(0.343)		
City							0.869***
							(0.08)
Constants	-0.189*	4.98***	-0.361**	0.294***	-0.599***	0.025	-0.211**
	(0.114)	(0.999)	(0.116)	(0.024)	(0.149)	(0.083)	(0.088)
Models	FE	FE	FE	FE	FE	FE	FE
N	210	210	210	210	210	210	210
R2	0.460	0.635	0.510	0.538	0.507	0.635	0.679
Sobel Test Statistic		3.165***		3.408***		4.944***	

*Note: Standard errors are in parentheses; *** P < 0.01; ** P < 0.05; * P < 0.1.*

Table 6. Heterogeneity regression results

	(1)	(2)	(3)	(4)	(5)
Variables	Eastern Region	Central Region	Western Region	Developed areas	Less developed regions
Dri	0.12**	0.758***	0.778***	0.113*	0.675***
	(0.055)	(0.079)	(0.081)	(0.064)	(0.067)
Gov	0.298	-0.135	-0.168**	0.043	-0.208**
	(0.212)	(0.127)	(0.073)	(0.257)	(0.063)
Human	-0.018	0.028*	0.02**	0.001	0.03**
	(0.021)	(0.016)	(0.009)	(0.022)	(0.009)
Market	-0.303	0.215**	0.086	-0.006	0.223***
	(0.243)	(0.071)	(0.064)	(0.212)	(0.055)
Lnenv	-0.014**	-0.007*	-0.008**	-0.009	-0.003
	(0.005)	(0.004)	(0.003)	(0.007)	(0.003)
Constants	0.767**	-0.19	0.003	0.418	-0.177**
	(0.274)	(0.148)	(0.094)	(0.262)	(0.086)
Models	FE	FE	FE	FE	FE
N	77	63	70	88	122
R2	0.281	0.876	0.858	0.175	0.769

*Note: Standard errors are in parentheses; *** P < 0.01; ** P < 0.05; * P < 0.1.*

From columns (3), (5) and (7) after adding the mediating variables, we can see that the regression coefficient of digital-real integration decreases compared with column (1) and the coefficient of each mediating variable is significantly positive, indicating that digital-real integration can accelerate high-quality economic development through other means, the results of the Sobel test also confirm the existence of mediating effects, and research hypotheses H2-H4 can be verified. Specifically, 15% of digital-real integration is indirectly transmitted through accelerating the urbanization process, 7.8% of the boosting effect is played by promoting the upgrading of industrial structure, and only 6.3% of the mediating effect comes from technological innovation. Since the positive impact of promoting urbanization involves multiple aspects, accelerating urbanization can effectively play its driving role. At present, China's technology dependence on foreign countries is high and the technology spillover effect is weak. In recent years, the introduction of high technology in China has accounted for more than 85% of exports, and some domestic basic technologies mainly rely on foreign imports, especially in the fields of electronics and intelligent manufacturing, etc. Tackling technological innovation has now become the key to building an innovation power in China. The independent research and development of technology and breakthroughs need time to accumulate, it is difficult to change in a short period of time, therefore, digital-real integration through the impact of technological innovation to play a weak role in promoting.

Heterogeneity analysis

Due to the differences in industry types, resource endowments and economic levels among regions, the impact of digital-real integration on high-quality economic development may be manifested in different degrees. Therefore, this paper investigates the heterogeneity of the impact of digital-real integration in terms of regional differences and economic development levels. According to the "Seventh Five-Year Plan", the observation objects are divided into three regions: East, Central and West, and the sample is divided into economically developed and less developed regions according to the average value of GDP per capita. As can be seen from Table 6, the regression coefficients of digital-real integration are significantly positive in the case of regional and economic level differences, but the effect is different, and the impact is more obvious in the central and western regions and less developed regions. This indicates that there is an obvious heterogeneous impact of digital-real integration on high-quality economic development.

Table 7. Robustness test regression results

Variables	Log GDP per capita	Lagged Phase I explanatory variables	Lagged Phase II explanatory variables
Dri	1.295***	0.225***	0.208***
	(0.13)	(0.043)	(0.049)
Control Variables	yes	yes	yes
Constants	8.039***	-0.008***	-0.009***
	(0.347)	(0.003)	(0.003)
Models	FE	FE	FE
N	210	180	150
R2	0.789	0.571	0.601

*Note: Standard errors are in parentheses; *** P< 0.01; ** P< 0.05; * P < 0.1.*

Robustness analysis

There are many factors influencing high-quality economic development, and it is difficult to study the impact of digital-real integration on high-quality economic development with full control of the remaining variables. Therefore, in this paper, the model is further tested using the substitution variable method and the instrumental variable 2SLS regression method to better enhance the explanatory power of the model results (see Table 7). (1) Substitution variable method. According to the definition of high-quality economic development, some scholars use the composite index or total factor productivity to measure it, but the fundamental of high-quality economic development lies in the sustained economic growth, and GDP per capita, which can most directly reflect the level of economic development, is used to express its development status. (2) Instrumental variables method. The lag-1 and lag-2 data of digital-real integration development index were selected as the instrumental variables, and three major tests (non-identifiable, weak IV, and over-identifiable) were performed on them respectively. The results show that the selected instrumental variables are reasonable and can be used for 2SLS regression analysis. From the two tests in Table 7, we can see that the nature of the impact of digital-real integration on high-quality economic development is similar to the previous results, and digital-real integration can still have a significant positive impact on high-quality economic development, indicating that the results of this paper have good robustness.

CONCLUSION AND RECOMMENDATION

This paper explores the impact of digital-real integration on high-quality economic development. After theoretical analysis of its mechanism of action, an empirical test is conducted using Chinese provincial panel data from 2014 to 2020. The study reveals that digital-real integration can significantly promote high-quality economic development, and there is heterogeneity among different regions and economic development levels, with stronger promotion effects in central and western regions and less developed regions. At the same time, it can also promote high-quality economic development by influencing technological innovation, industrial structure and urbanization process, with the strongest boosting effect through urbanization development and the weakest mediating effect of technological innovation. In order to accelerate digital-real integration and make it play a better role in promoting high-quality economic development, this paper makes the following suggestions based on the findings of empirical evidence. First, strengthen the top-level design and develop a reasonable fusion market supervision and governance system. The government has inhibited intervention in economic development, and a good balance between the government and the market is the fundamental guarantee to promote the development of digital-real integration. The government needs to introduce relevant platform management policies and digital-real integration standards, supervise digital technology for reasonable and compliant fusion applications, and strengthen the security of data and information. At the same time, the government needs to control the direction of digital development, guide the market to compete in an orderly manner, manage the misconduct of abusing digital economy to dominate the market operation, build a digital governance system, strengthen the self-regulatory behavior of enterprises, create an environment of common construction, governance and sharing, and promote the fair development of digital-real integration.

Second, deepen the innovation cultivation and strengthen the investment in R&D. At present, some of China's core technologies are still in the "neck" stage, and digital-real integration plays only 6.3% of the boosting role by influencing technological innovation. Each region should strengthen the construction of digital talent team, create a digital talent training model of cooperation between industry, academia and research institutes in multiple fields, and forge a group of all-round talents with digital thinking and technology application ability by establishing a digital talent innovation training center. At the same time, we should increase the investment of technical talents and funds, continuously improve the independent research and development capability of technological innovation, reduce the dependence on foreign markets, and strive to create a situation of independent self-control and self-sufficiency of key core technologies to ensure the stable development of the production and supply chain.

Third, create a sharing platform and strengthen regional cooperation. There are differences in the impact of digital-real integration on high-quality economic development among regions with different economic bases and development resources. In order to enhance the synergy of development among regions, each region should strengthen regional cooperation and make joint efforts to promote the development of digital-real integration. Regional governments should take the lead in building multi-functional resource sharing service platforms to further strengthen the integration capacity of data, break down information silos, promote multi-resource sharing and cooperation and exchange, and better stimulate the potential of market demand. At the same time, the eastern and economically developed regions should combine their own resource advantages, focus on strengthening 5G base stations, industrial internet and other new base construction, improve data transmission and network operation capacity, and comprehensive development of convergence economy. While the central and western and less economically developed regions should fully implement the traditional infrastructure digital transformation project, based on the local industrial structure and development strength, promote the digital

transformation of industry, and give full play to the late-development advantage to promote high-quality economic development.

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