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The Digital Economy on Industrial Agglomeration: Inhibitor Or Facilitator?

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Abstract

We use panel data from 30 provinces in China from 2011-2021 to discuss the role of the digital economy in influencing industrial agglomeration and its underlying mechanisms. The findings show that, firstly, the digital economy has a significant positive impact on the level of industrial aggregation, and this finding still holds after endogeneity and robustness tests, with the digital economy becoming an essential enabler for the high-quality development of the real economy. Secondly, the digital economy also affects industrial agglomeration through technological innovation, which plays a transmission mechanism, indicating the importance of enhancing technological innovation to modernize the industrial system. This study demonstrates the critical role of the digital economy in promoting industrial agglomeration and provides practical solutions for advancing the high-quality development of the real economy.

Keywords

Digital Economy; Industrial Clustering; Digital Technology; Collaborative Innovation.

1. Introduction

With the deepening of economic globalization, increasing trade frictions and geopolitical issues becoming prominent, the security of industrial chain supply chains ushers in significant challenges. Industrial chain supply chain security is an essential endogenous force for smooth domestic circulation and a binding force for accelerating the construction of a modern economic system. Maintaining industrial chain supply chain security and enhancing the resilience of industrial chain supply chains are fundamental requirements for promoting high-quality economic development. However, industrial chain supply chain security needs to be based on grasping resilience, enhancing the anti-risk capacity and recovery ability of industrial subjects, strengthening the adaptability and plasticity of industrial chain subjects, and thus stabilizing industrial chain supply chain subjects. In particular, industrial agglomeration can, to a certain extent, enhance the overall resilience of industrial chains by influencing technological innovation[1]. The degree of industrial agglomeration can indicate the degree of industrial linkage in a particular geographical area, and production factors such as humans, capital, and materials are constantly converging in space, forming a multi-industrial fusion and thus contributing to the increasing resilience of the regional industrial chain. At the same time, the digital economy can rely on advanced digital technologies such as big data, cloud computing, and artificial intelligence to break the barriers of time and space, improve the efficiency of information exchange and accelerate the circulation of factors, thereby building an industrial collaborative innovation ecosystem. So, as an essential economic development model today, can the digital economy enhance industrial agglomeration? And if so, in what ways? We think. Addressing these questions will help us better understand the relationship between industrial accumulation and the digital economy. It can also help us formulate policies from the digital economy's perspective to promote the development of industry chain supply chains. Therefore, we believe it is necessary to explore the relationship between the digital economy and industrial accumulation in depth, which will help us further grasp the safe development of

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industrial chain supply chains and build a solid supply chain under the new development pattern.

A literature review reveals that research on industrial agglomeration is multifaceted and multidimensional. Pons (2002) provides an in-depth analysis of trade liberalization and industrial accumulation in Spain, finding that the size of the regional economy contributed to industrial agglomeration and that trade protection policies did not contribute sufficiently to industrial agglomeration in Spain in the 19th century.[2] In his study on industrial accumulation and inter-regional labor productivity, Fan Jianyong (2006) found that the elasticity coefficient of labor productivity of non-agricultural industries to non-agricultural employment in Mordor in China is around 8.8% and that this agglomeration efficiency should vary between provinces both with and without differences, which would widen the differences in labor productivity between areas in the case of uneven distribution of non-agriculture.[3] . Dong ((2020) shows that as industrial agglomeration grows, the pressure of environmental pollution increases and that the problem becomes particularly acute in the later stages of industrial accumulation, which is also very serious in northern China. In this regard, the authors suggest optimizing the layout of technological innovation and strengthening regional synergy[4]. Liu Xinzhi (2022) shows that industrial accumulation and technological innovation can enhance the high-quality economic development of China's five major urban agglomerations. Industrial agglomeration can have a transmission effect through technological innovation. In addition, there are differences in the contribution of different industrial clusters to high-quality economic development, with a significant negative impact of industrial agglomeration in traditional industry and agriculture and a significant positive effect in the We have found from the above literature that most studies have analyzed industrial accumulation and economic development, but have not yet explored which factors can influence industrial agglomeration, nor have the paths of influence behind them been clarified, so we believe that this issue needs to be considered in depth.

As a coupled product of industrial digitisation and digital industrial development, the digital economy represents a new economic form and social business model. Enterprise management and business models centered on digital technologies such as artificial intelligence, the Internet of Things, and big data blockchain continue to develop and gradually replace traditional organizational business models, accelerating economic growth while placing more stringent requirements on application scenarios[6]. In terms of macro impact, the digital economy can influence the consumption patterns of regional residents. Among other things, the development of the digital economy significantly increases the level of consumer spending by locals and, through digital payment platforms, increases the convenience of payments, reduces liquidity constraints, and reduces the uncertainty of credit risk in transactions. In addition to this, there are significant differences in the impact of the digital economy on residents' consumption due to the geographical location, city size, and city-level consumption between cities, resulting in significant differences in the impact of the digital economy on residents' consumption, not to mention further reducing the gap in residents' consumption between urban and rural areas[7]. At the same time, the digital economy can, to a certain extent, contribute to the low-carbon transformation of cities due to its green attributes. It has been documented that the digital economy can contribute to the green development of cities by enhancing green technology innovation, and this finding has been reinforced more effectively in the central region. From a micro perspective, the Internet carries digital technology, and with the continuous development of the Internet economy, the Internet will become a new economic growth point. In the future, the Internet economy will revolve around the digital economy, smart manufacturing, smart cities, and other areas, forming new industrial chains and industrial ecologies. The Internet economy will become an important force in driving economic development. The Internet, however, has problems such as higher risks and less information

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disclosure, which significantly increases uncertainty in the transaction process between supply and demand, and credit risks can accumulate in the transmission of data chains, destabilizing factors are further amplified, and the security and resilience of the economy are challenged.

In summary, the role of industrial accumulation and the impact of the digital economy on economic development have been discussed to some extent. Still, the relationship between industrial agglomeration and the digital economy has been less explored, and the transmission path between the two has not yet been clarified. So, can the digital economy, relying on digital technology, enhance the industrial agglomeration of cities? What are the paths through which the digital economy can influence industrial agglomeration? We believe that answering these questions will help us grasp the elements of industrial agglomeration development, build a high-quality industrial chain chain chain system, and thus promote economic modernization and development. Based on this, this paper uses data from 2011-2021 for Chinese cities at the prefecture level and above to analyze the relationship between the digital economy and industrial agglomeration at a macro level and further explore the mechanisms behind the two. Our study will probably provide a new theoretical basis and empirical evidence for the innovation of high-quality development of digital economy and industrial chain supply chains.

2. Theoretical Assumptions

2.1. Direct Effects of the Digital Economy on Industrial Agglomeration

From a theoretical perspective, the promotion of industrial agglomeration by the digital economy is primarily manifested in the upgrading and transformation of traditional industries. On the one hand, the digital economy has high permeability. Through the Internet, e-commerce, and cloud computing, digital technology, digital services, and digital information penetrate all aspects of production, operation, and sales of traditional industries, improving industrial efficiency, upgrading the digital level of enterprises, promoting the transformation of traditional industries, realizing the optimization and upgrading of industrial structures, and thus strengthening the interconnectedness between various sectors and enhancing industrial accumulation [9]. On the other hand, the digital economy's development has changed traditional industries' production methods, enabling them to change towards intelligence and personalization. Digital technology and intelligent equipment are widely used in production, which can improve labor productivity and resource utilization in traditional industries and realize the intellectual and digital development of traditional industries. In the industrial economy, scale, and standardization were the main production methods based on cost and efficiency considerations. In the digital economy, products and markets are constantly subdivided, and the trend is toward personalized product development according to user needs. Standardized production methods are gradually changing into personalized and differentiated products, which helps to stimulate production demand and increase the intrinsic vitality of enterprises. Digital technology promotes the reengineering of internal processes in traditional industries and improves industrial efficiency. Under the e-commerce transaction model, products can be delivered to users regardless of time and location, expanding the scope of transactions, reducing transaction costs, speeding up the circulation of resources, and triggering the reengineering of enterprise processes. The application of big data technology, etc., can obtain user profiles and then, through the integration of industry chain resources, make the production, operation, and sales of traditional industries better meet user needs, thus promoting the development of traditional industries and improving their competitiveness. The digital economy changes how the industry is organized and stimulates industrial innovation. With the continuous innovation and development of digital technology, the platform economy is developing rapidly. Under the platform economy, the industrial organization has changed from chain type to network collaboration type, and the development of subcontracting and

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crowdsourcing models has brought more business opportunities to SMEs. The new models and rules under the platform economy reconfigure the industrial ecology, digital energy is continuously released, and industry innovation and creative capacity are significantly enhanced, which helps traditional industries change and improve industrial agglomeration[10]. Based on this, we put forward the following hypothesis:

Hypothesis 1: The digital economy can enhance urban industrial agglomeration.

2.2. Indirect Effects of Technological Innovation

Digital technology is the core force behind the development of the digital economy, and how to improve technological innovation in digital technology has become an essential issue in promoting the development of the digital economy. Technological innovation, as a fundamental power source for high-quality economic development, can also promote industrial agglomeration development to a certain extent. From a theoretical perspective, the reasons for this may lie in the following three aspects: firstly, technological innovation can increase the amount of regional intellectual capital to raise the wages of R&D personnel and promote the accumulation of high-technology industries. The increase in innovation factor inputs and patents will increase the restricted stock of intellectual capital, which is the total amount of knowledge resources an organization or economic system possesses at a particular stage. The amount of regional intelligent money is derived from the amount of knowledge held by patents or individuals, as well as the R&D factor inputs in the region. Increasing the number of R&D factors and patents, therefore, increases the amount of regional intellectual capital, raises the wages of the region's workforce, and encourages more R&D personnel to congregate there, changing the spatial distribution of intellectuals and improving regional technological innovation. R&D investment is transformed into innovative results such as patents and new products produced, and high-tech industries gather here to obtain more R&D investment, share the results of patents, and improve their competitiveness. Secondly, technological innovation can reduce production costs and create economies of scale, promoting the accumulation of high-tech industries. Innovation factors are used as fixed inputs in the manufacturing sector, while ordinary laborers are used as variable inputs. In the R&D sector, innovation is produced by R&D factors and patents as inputs, so an increase in R&D factors and patents can contribute to the rise in innovation output. Each firm producing a product requires inputting new knowledge and a variable amount of general labor. The manufacturing sector purchases innovative products from the R&D sector, creating a fixed input, and the increase in patents increases the labor productivity of workers, increasing the output produced by the average worker and reducing the average cost of the manufacturing sector, creating an economy of scale effect. In this case, the manufacturing sector clusters in areas with more innovation factors to obtain patents produced by the R&D sector, and regions with more R&D workers and R&D capital supply more to the manufacturing sector.

On the other hand, high-tech industries are more dependent on the innovation sector, and therefore STI can influence the accumulation of high-tech enterprises. Thirdly, science and technology innovation can promote the expansion of high-tech industries by generating spatial spillovers. According to the knowledge externality study of endogenous growth theory, science and technology inputs, and innovation results have significant spatial spillover effects, i.e., R&D inputs and patent outputs, as necessary innovation resources, not only enable the enterprises and the region to obtain innovation benefits but also spill over to other enterprises and regions and bring positive effects. This will be reflected in promoting innovation output and improved economic benefits at the firm level. In contrast, at the regional level, it will be reflected in promoting agglomeration effects and improved development quality. Based on this, we propose the following hypothesis:

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Hypothesis 2: The digital economy can drive the development of urban industrial clusters by enhancing technological innovation.

3. Study Design

3.1. Sample Selection and Data Sources

Using panel data from 30 Chinese provinces (excluding Tibet, Hong Kong, Taiwan, and Macau) from 2011-2021, the effect of the digital economy on industrial agglomeration is examined. The selection of provincial macro data is mainly based on the fact that the development of industry chain supply chains is based on regional macroeconomic development and expressed through regional macro indicators, so the selection of local data to measure industrial agglomeration is of solid practical significance. At the same time, the data were mainly obtained from China Statistical Yearbook, China Demographic Yearbook, China Financial Statistical Yearbook, China Financial Statistical Yearbook, and relevant data released by local governments, etc. To enhance the study's credibility, very few missing data were filled by linear interpolation.

3.2. Selection of Variables

Table 1. Comprehensive evaluation indicators for the digital economy

Target indicators	Tier 1 indicators	Secondary indicators	Indicator Description	Properties
Digital Economy	Digital industry	Percentage of digital industry personnel/%	Business employment in information transmission, computer services, and software / total regional year-end population	+
		Size of software business revenue / RMB million	Software business revenue was taken as a logarithm	+
		Size of information services revenue / RMB million	Information services revenue taken as the logarithm	+
	Digitalization of industry	Internet penetration rate/%	Number of interconnected access ports / total regional year-end population	+
		Mobile phone usage/%	Number of people with mobile phones / total population in the region at the end of the year	+
		Fiber optic cable density/%	Length of fiber optic cable/length of road	+
		E-commerce transaction size / RMB million	Total e-commerce transactions are taken as a logarithm.	+
	Digital Finance	Digital Finance Index	Digital Inclusive Finance Index published by Peking University Institute of Digital Finance	+
		Depth of use		+
		Breadth of coverage		+
		Degree of digitization		+

Explained variable: Industrial agglomeration (IC) Industrial agglomeration refers to the degree of distribution of related enterprises and institutions in a particular region and is a primary indicator of industrial agglomeration effects. By measuring the degree of industrial aggregation,

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we can understand the scale and intensity of industrial development and support government departments in formulating industrial development policies and promoting the synergistic effect of industrial clusters. Drawing on existing research[11], we use the total output value of secondary industries in each region to calculate the location entropy to measure the degree of industrial agglomeration.

Explanatory variable: digital economy (DE) A review of existing studies reveals that the measurement of the digital economy focuses on two approaches: firstly, the measurement indicators are constructed from four dimensions: industrial digitization, digital industrialization, digital governance, and data valorization, and the digitization of industries is measured by internet access ports and mobile phone penetration rates, and the digitization is measured by the revenue-to-GDP ratio of the electronic information industry and the software industry to evaluate the level of development of the digital economy comprehensively. Secondly, as digital financial inclusion covers both the Internet and money circulation, two significant digital economies support, some scholars use the digital financial inclusion index to measure the digital economy. Drawing on existing research and based on the essential characteristics and realistic representations of the digital economy, the digital economy of each province is evaluated in three dimensions: industrial digitization, digital industrialization, and digital finance, and the entropy value method is used to measure the comprehensive evaluation index, see Table 1 for specific indicators.

Control variables: We selected the following control variables: ①level of government intervention (gov), measured using the ratio of general fiscal expenditure to regional GDP. ②level of human capital (hum), measured using the ratio of people in the region with a bachelor's degree or higher to the total population. ③ GDP per capita (pgdp), measured as the ratio of total regional population to regional GDP at the end of the year. ④Openness to the outside world (open), measured using the ratio of total foreign investment to general fiscal expenditure for the year. ⑤ Education level (edu), measured using the ratio of government expenditure on education to public budgetary spending.

3.3. Model Design

First, to test the effect of the digital economy on industrial aggregation, the following benchmark regression model is constructed:

$$IC_{it} = \alpha_0 + \alpha_1 DE_{i,t} + \alpha_2 X_{i,t} + \lambda_i + \gamma_t + \varepsilon_{i,t} \quad (1)$$

In equation (1), it is the level of industrial agglomeration in the province I in year t, DEit is the level of the digital economy in area I in year t, Xit denotes all control variables, λ denotes individual fixed effects, γ denotes time-fixed results, and ε is a random disturbance term.

Secondly, according to the aforementioned theoretical analysis, the digital economy can promote the enhancement of technological innovation, and technological innovation will also promote the development of industrial agglomeration, considering that there may be intermediary effects of technological innovation, we construct a mechanism test model, based on the existing direct impact of (1), we construct (2) to test the promotion effect of the digital economy on technological innovation, and make (3) to try whether technological innovation can play an intermediary role in the total product. Can play a mediating role, the model is specified as follows:

$$TI_{i,t} = \beta_0 + \beta_1 DE_{i,t} + \beta_2 X_{i,t} + \lambda_i + \gamma_t + \varepsilon_{i,t} \quad (2)$$

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$$IC_{i,t} = \varphi_0 + \varphi_1 DE_{i,t} + \varphi_2 TI_{i,t} + \varphi_3 X_{i,t} + \lambda_i + \gamma_t + \varepsilon_{i,t} \quad (3)$$

3.4. Descriptive Statistics

Table 2 shows the results of descriptive statistics for the variables involved in the study. Among them, the mean value of industrial agglomeration (IC) is 0.3522, the minimum value is 0.0645, and the maximum value is 0.8734; the maximum value is much larger than the mean and the minimum value, indicating that the industrial agglomeration varies significantly between regions. The digital economy (Dig) and technological innovation (IE) also show a significant difference between the maximum value and the mean and minimum value, indicating that there is also a specific difference in the level of development of the digital economy and technological innovation in different regions. At the same time, all the control variables have different degrees of variation, further confirming the value of the study.

Table 2. Descriptive statistics results

Variables	Volume of observations	Average	Standard deviation	Minimum value	Maximum value
IC	330	0.3522	0.2946	0.0645	0.8734
DE	330	0.8412	1.6901	0.1572	2.9182
TI	330	2.5231	0.2191	1.1645	15.3462
gov	330	0.3151	0.1623	0.2764	0.8242
hum	330	0.5304	0.0421	0.3251	0.8153
pgdp	330	0.7217	0.3727	0.1523	4.2395
open	330	0.2537	1.9037	0.0129	9.8129
edu	330	0.2166	0.1265	0.1253	0.4161

4. Empirical Analysis

4.1. Baseline Regression Results

The results of the test for the direct effect of the digital economy on industrial accumulation are shown in Table 3. We increase the credibility of the trial; control variables are added sequentially from columns (1) to (6) in Table 3 to analyze the direct effect of the digital economy on industrial agglomeration under different control variables and fixed for time and individuals. The results show that the coefficients of the digital economy on industrial agglomeration pass the 1% significance test. They are positive under different control variable scenarios, indicating a significant promotion effect of the digital economy on industrial aggregation. The higher the level of development of the digital economy, the higher the level of industrial agglomeration, and hypothesis 1 holds. The main reasons for this are as follows: the digital economy enhances the information-sharing ability of industries: the digital economy provides an efficient platform for information sharing, which makes the transfer of information between different sectors more convenient and rapid. As a result, various industries can communicate and collaborate more smoothly, which promotes industrial innovation and iterative upgrading, and strengthens the connection and cooperation between sectors; the digital economy improves the level of automation in industrial fields: many technological innovations in the digital economy are centered on the concept of automation, and these technological innovations can significantly improve the production efficiency of industries and reduce labor costs, while also enhancing the competitiveness and core strengths. The digital economy promotes innovation and entrepreneurship: the digital economy can provide more

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innovation opportunities for enterprises, especially for start-ups, which can rely on the advantages of the digital economy to gain competitive advantages in the market through innovative products or services, thus achieving the purpose of industrial aggregation; the digital economy strengthens resource integration and sharing: the openness and sharing nature in the digital economy allows different enterprises to share resources at the same time It can also enhance the discourse and jointly solve everyday problems, thus forming an industrial agglomeration effect.

Table 3. Baseline regression results

	(1) *IC*	(2) *IC*	(3) *IC*	(4) *IC*	(5) *IC*	(6) *IC*
DE	0.3641*** (2.78)	0.3215*** (3.04)	0.3835*** (3.17)	0.3789*** (3.65)	0.3256*** (3.88)	0.2854*** (3.76)
gov		0.1574 (1.65)	0.1462 (1.63)	0.1372 (1.57)	0.1723 (1.45)	-0.1454 (-0.78)
hum			-0.0769 (-1.61)	-0.0358* (-1.96)	-0.1485* (-1.23)	0.4583** (2.62)
pgdp				-0.0246*** (-3.32)	-0.2346*** (-2.43)	0.7232** (2.72)
open					0.0457** (2.74)	0.0786*** (3.28)
edu						0.0583*** (3.25)
Fixed time	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixation	Yes	Yes	Yes	Yes	Yes	Yes
Constant term	0.1137*** (8.34)	0.1856*** (4.13)	0.1284*** (4.64)	0.2844*** (3.56)	0.1424*** (4.99)	0.1458*** (4.26)
Observations	330	330	330	330	330	330

Note:*,**,*** indicate significance at the 10%, 5%, and 1% levels, respectively, with t-values in brackets.

4.2. Robustness Analysis

Further, the following three aspects were tried to test the robustness of the above benchmark regression results: First, the explanatory variables were replaced. Considering that the impact of the digital economy on industrial agglomeration has a lagged effect, a one-period lag of industrial agglomeration is taken as the explanatory variable, and a model (1) type regression is conducted. Secondly, the sample is replaced. Considering that municipalities directly under the central government have more concentrated resources, enjoy policy support and tax incentives, and have strong economic vitality, they may play a more prominent role in the impact of the digital economy on the level of industrial agglomeration, and thus ignore the promotion effect of other regions, the original sample is excluded from the four municipalities directly under the central government of Beijing, Shanghai, Tianjin, and Chongqing, and the model (1) is regressed. Third, the model was replaced. Since the fixed-effects model takes individual variable characteristics as explanatory variables when testing the digital economy on the industrial agglomeration level, it does not consider the potential randomness of personal varying characteristics. The fixed-effects model was replaced with a mixed-effects model (OLS), and the robustness test was conducted again. Table 4 shows the robustness test results, where column (1) of Table 4 reports the regression results after replacing the explanatory variables. The regression coefficient of the digital economy is significant and positive at the 1% level,

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indicating that the digital economy still contributes to the industrial agglomeration level after a one-period lag. Column (2) of Table 6 reports the regression results after the municipalities' removal. The coefficient of the digital economy is 0.3462. It is significant at the 1% level, indicating that the digital economy still has a catalytic effect on the industrial agglomeration level after the municipalities' removal. Column (3) of Table 6 reports the results of the mixed-effects model regression, where the regression coefficient of the digital economy is positive and significant at the 1% level, indicating that the boosting effect of the digital economy still exists significantly when individual variable characteristics are used as the random error term. In summary, all three tests indicate that the results of the benchmark above regressions are highly credible and robust.

Table 4. Robustness tests

	(1) *L.IC*	(2) Excluding municipalities	(3) OLS model
DE	0.1946*** (3.76)	0.3462*** (4.79)	0.5171*** (3.56)
Control variables	Yes	Yes	Yes
Fixed time	Yes	Yes	No
Individual fixation	Yes	Yes	No
Constant term	0.1282*** (4.45)	0.2452*** (3.56)	0.5211*** (2.87)
Observations	330	286	330

Note:*,**,*** indicate significance at the 10%, 5%, and 1% levels respectively, with t-values in brackets.

5. Further Research: Testing the Mechanism

According to the aforementioned theoretical analysis, the digital economy will promote industrial agglomeration through the technological innovation channel. To test this transmission mechanism hypothesis, an empirical test was conducted using model (2) and model (3), and the regression results are shown in columns (1) and (2) of Table 5. The results in column (1) of Table 5 shows that the regression coefficient for the digital economy is significant at the 1% level, indicating that the digital economy has a positive impact on technological innovation and that the development of the digital economy positively contributes to the increase in technological innovation. Finally, placing technological innovation in the regression equation of the digital economy on the level of industrial agglomeration, observing column (2) of Table 5 shows that the regression coefficients of the digital economy and technological innovation pass at least the 10% significance test, indicating that technological innovation can play a mediating role. Still, hypothesis 2 is verified due to the significance of the regression coefficients of the mediating variables, meaning that technological innovation assumes a partial mediating role. It may be because digital technology can increase the automation and intelligence of industries, thereby reducing production costs and improving production efficiency. For example, innovative manufacturing technologies can improve production efficiency, optimize production processes, and increase product quality and production line safety. At the same time, the increased level of technological innovation optimizes supply chain and logistics management. Digital technology can improve the transparency of supply chain information and logistics management, speed up information transfer and logistics transportation, reduce logistics and supply chain costs, and thus increase the degree of industrial agglomeration.

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Table 5. Intermediary mechanism test results

	(1) IT	(2) IC
DE	0.2511*** (3.27)	0.3822*** (3.94)
IT		0.1342*** (3.11)
Control variables	Yes	Yes
Fixed time	Yes	Yes
Individual fixation	Yes	Yes
Constant term	0.3383*** (2.15)	0.1734*** (1.56)
Observations	330	330

Note:*,**, and*** indicate significance at the 1%, 5%, and 10% levels, respectively.

6. Conclusion and Policy Recommendations

Using panel data from 30 provinces in China from 2011-2021, we discuss the role of the digital economy in influencing industrial agglomeration and its underlying mechanisms. The findings show that, firstly, the digital economy has a significant positive impact on the level of industrial aggregation, and this finding still holds after endogeneity and robustness tests, making the digital economy an essential enabler for the high-quality development of the real economy. Secondly, the digital economy also influences industrial agglomeration through technological innovation, which plays a role as a transmission mechanism, indicating that enhancing technological innovation is essential for modernizing the industrial system. Based on the above research findings, the following practical policy recommendations are proposed:

First, The government should continue to promote technological innovation and strengthen personnel training. Technology is the core driver of the development of the digital economy. By strengthening support for scientific research and technological innovation, promoting digital technology, tapping into the value of data, and creating digital governance and service tools, we will provide technical support and a talent pool for the rapid rise of the digital economy.

Secondly, the digital economy industry has high requirements for infrastructure and needs the support of high-quality networks, communications, and data centers. Therefore, the government and enterprises need to work together to promote the development of cloud computing, big data, the Internet of Things, and other related technologies, build advanced digital economy infrastructure, improve the development of digital economy industries, and meet the needs of digital economy development.

Thirdly, the digital economy industry has high requirements for infrastructure and needs the support of high-quality networks, communications, and data centers. Therefore, the government and enterprises need to work together to promote the development of cloud computing, big data, the Internet of Things, and other related technologies, build advanced digital economy infrastructure, improve the development of digital economy industries, and meet the needs of digital economy development.

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