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Original Paper

How Does Digital Technology Innovation Affect Manufacturing Industry Agglomeration?

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Abstract

This paper takes 270 Chinese cities as the sample, and measures the level of manufacturing industry agglomeration based on the dual perspective of science and technology expenditure level and regional Internet penetration rate. In this paper, a fixed effect model is used to investigate the effect and mechanism of digital technology innovation on manufacturing industry agglomeration. The results show that: (1) digital technology innovation has a significant positive driving effect on manufacturing industry agglomeration, and the conclusion is still valid after the endogenous processing test. (2) Mechanism analysis shows that digital technology innovation promotes industrial agglomeration through dual channels of "innovation element adsorption" and "digital infrastructure empowerment". Specifically, it is reflected in improving the intensity of local government science and technology expenditure, accelerating the diffusion of regional Internet penetration, thereby optimizing the regional innovation ecosystem and reducing the cost of factor space allocation. This paper not only provides theoretical basis for analyzing the spatial reorganization law of manufacturing industry in the era of digital economy. It also provides policy inspiration for local governments to enable the upgrading of traditional industrial clusters through digital technology and build a "technology-industry-space" coordinated development pattern. It is practical to promote manufacturing industry and regional coordinated development strategy.

Keywords

Digital technology innovation, Manufacturing industry agglomeration, Mechanism test

1. Introduction

The digital transformation of the global manufacturing industry has risen to the dimension of national

strategic competition. Major economies have taken the collaborative evolution of digital technology and industrial agglomeration as the key to reshaping competitive advantage (Wu and Yang, 2004). In the 14th Five-Year Plan, China systematically deploying smart manufacturing and clustering development paths through the "Made in China 2025" strategy. The European Union has released the 2030 Digital Compass Plan, which prioritizes the construction of industrial data Spaces and the digitization of manufacturing. The United States "Advanced Manufacturing National Strategy" emphasizes the reconstruction of industrial chain resilience with digital threading technology. This series of policy layouts shows that digital technology is no longer limited to productivity improvement tools, but has become a core variable to restructure the geographical distribution and organization of global manufacturing. The basic logic of the traditional industrial agglomeration theory, such as geographical proximity and factor cost driving, is facing the dual challenges of value chain deconstruction and spatial re-embedding caused by digital technology.

Driven by policies, the transformation of digital technology to manufacturing agglomeration has been extended from the technical application level to the institutional innovation level. China has launched the "Digital Transformation Partnership Action" and the "Data Elements X Three-year Action Plan" to break barriers to cross-regional data flow and promote synergy in industrial chain virtualization. The EU establishes a framework for cross-border industrial data sharing through the Data Governance Act, trying to balance technology monopoly and cluster fairness; In the United States, the Chip and Science Act strengthened the support of digital infrastructure for local manufacturing clusters. These policy practices reveal that digital technologies are reshaping the underlying rules of agglomeration: the industrial Internet weakens physical spatial constraints, artificial intelligence reconstructs knowledge spillover paths, and blockchain technology spawns trusted collaborative networks (Shi and Du, 2022). However, technology diffusion has also derived new governance propositions, the inter-regional digital divide may exacerbate the development imbalance, and small and medium-sized enterprises in traditional industrial clusters are faced with the dilemma of digital ecological integration. How to achieve the balance between agglomeration efficiency and spatial justice in technological innovation and institutional design will become the core issue in the evolution of global manufacturing pattern.

This is the rest of the paper: The second section is the literature review, systematically examining existing research on digital technological innovation, manufacturing agglomeration dynamics, and related theoretical domains. The third section advances a theoretical framework by dissecting the underlying mechanisms linking these elements. This is followed by the fourth section, which outlines the methodological approach, encompassing model specification, variable operationalization, and data characterization. The fifth section presents empirical analyses, rigorously testing the proposed hypotheses against the data. Ultimately, the concluding section synthesizes the key findings and proposes actionable policy insights grounded in the research outcomes.

2. Literature Review

2.1 Related Research on Digital Technology Innovation

Digital technology innovation is the core driving force of industrial change, and its multi-dimensional influence mechanism has been widely discussed in the academic circle. Existing studies are mainly carried out from the following dimensions: At the macro level, digital technology innovation significantly enables economic development and ecological civilization construction by optimizing factor allocation efficiency and reconstructing production function structure, and becomes a new engine to improve total factor energy efficiency and modernization level (Lv et al., 2025; Xiao et al., 2025). At the medium level, digital technology strengthens the externality effect of regional innovation network through digital financial innovation, scientific research and development investment and the cultivation of new industrial formats, and promotes the innovation of carbon emission reduction path by relying on the reconstruction of low-carbon production mode (Ma Qin, 2025; Liu et al., 2025). At the micro level, digital technologies penetrate deeply into the entire process of enterprise operations. It is manifested in improving the governance efficiency of state-owned enterprises, enhancing the green total factor productivity of manufacturing industry, optimizing the supply chain elasticity of circulation enterprises, and strengthening the resilience of enterprises to export risks through digital transformation (Li, 2025; Wang & Li, 2025; Zhu & Li, 2025; Wang et al., 2025). Through the digitalization of energy monitoring and intelligent resource management, it provides an emerging technology path for the improvement of energy conservation and emission reduction performance (Ma & Lin, 2025).

2.2 Related Research on Manufacturing Industry Agglomeration

First, the economic factor level. The deepening and specialization of digital finance have become the core economic driving force for agglomeration development by optimizing the efficiency of factor allocation and reducing transaction costs. Regional economic synergy under the guidance of high-quality development further strengthens the spatial positive externality of agglomeration (Dong et al., 2025; Zhang et al., 2023; Millika, 2023). Second, geography and infrastructure. The accessibility of high-speed transportation network reconstructs the location choice logic and accelerates the concentration of manufacturing industry to hub node cities. At the same time, the spillover effect of infrastructure amplifies the agglomeration scale return (Hou, 2025). Third, the environmental effect level. The environmental impact of agglomeration presents dual characteristics. Pollution pressure may be alleviated through green technology innovation and intensive use of resources, or ecological carrying capacity overload may be caused by excessive agglomeration, the net effect of which depends on the dynamic game between technology spillover and pollution spillover (Zho et al., 2021; Li et al., 2019). In addition, studies from the perspective of globalization reveal the restructuring effect of FDI on regional agglomeration pattern through technology diffusion and industrial chain embedding, but there is significant spatial heterogeneity (Shi & Wu, 2020).

Based on the above studies, the research on digital technology innovation and manufacturing industry agglomeration still has the following room for improvement: First, the existing research provides a

theoretical basis for revealing the economic and ecological dual value of digital technology, but the dynamic mechanism of its spatial restructuring effect is still insufficient. In particular, there is a lack of systematic explanation of the game relationship between "agglomeration viscosity" and "geographical dilution" caused by digital technology. Second, the dynamic evolution mechanism of agglomeration form under the impact of digital technology and the collaborative path of "efficiency-ecology-resilience" are still lacking. Third, in terms of value objectives, existing studies often focus solely on efficiency improvement or pollution control. The collaborative realization path and tradeoff mechanism of manufacturing agglomeration process goal driven by digital technology cannot be systematically revealed.

Therefore, the possible marginal contribution: First, connect digital technology innovation with manufacturing industry agglomeration, and explore the deep relationship between them. Secondly, through science and technology expenditure and Internet penetration rate, the paper explores the mechanism of digital technology innovation affecting manufacturing industry agglomeration. Finally, to promote the deep integration of digital technology economic theory and spatial economics, to provide a new paradigm for the study of industrial layout in the era of digital transformation.

3. Research Hypothesis

3.1 Direct Impact Mechanism and Research Hypothesis

Digital technology innovation directly promotes manufacturing industry agglomeration through three core paths: reducing transaction costs, reconstructing knowledge spillover mode and strengthening innovation collaborative network. First, technologies such as industrial Internet platforms and blockchain effectively reduce information asymmetry and collaboration friction in the upstream and downstream of the industrial chain through real-time data sharing and smart contract mechanisms (Sun Daming et al., 2025). In order to obtain the network efficiency of digital collaboration, enterprises tend to concentrate in areas with dense digital infrastructure, forming a new agglomeration form with digital hub as the core. Second, technologies such as digital twins and virtual collaboration tools break through the physical constraints of geographic boundaries. The traditional tacit knowledge transfer dependent on geographical proximity is transformed into an explicit knowledge flow that can be encoded and spread across domains. While expanding the radius of knowledge spillover, it still strengthens the enterprises' dependence on the key technology node region, and promotes the mixed agglomeration of "digital-geographic" dual proximity. Third, the intelligent decision system driven by artificial intelligence and the industrial cloud platform dynamically integrate R&D, production and market resources. A modular and scalable innovation ecosystem is built, and complementary technology entities are encouraged to form deep nested collaborative networks in specific regions to achieve a positive cycle of technology iteration and industrial economies of scale.

Hypothesis 1: Digital technology innovation can directly promote the level of China's manufacturing industry agglomeration.

3.2 Indirect Transmission Mechanism and Research Hypotheses

3.2.1 Analysis on the Mediating role of the Level of Science and Technology Expenditure

Digital technology innovation indirectly promotes the manufacturing industry agglomeration by stimulating regional innovation input. For one thing, based on the endogenous growth theory, digital technology as a universal technology (GPT) significantly improves the R&D efficiency and risk bearing capacity of enterprises. Forcing local governments and enterprises to increase the scale of science and technology spending to seize the commanding heights of technology. Form a circular cumulative effect of "digital technology application - R & D efficiency improvement. For another thing, based on the theory of regional innovation system, digital technology integrates cross-regional R & D resources through the industrial Internet platform, prompting science and technology expenditure to shift from decentralized investment to core technology research focusing on the key industrial chain. This kind of directed investment further strengthens regional technological advantages, attracts upstream and downstream enterprises to gather in the innovation pole core of high R&D density, and forms a chain reaction of "technological potential energy - factor adsorption - cluster symbiosis". In this process, the government-led "new nationwide system" and the market-driven "digital technology-industrial demand" adaptation mechanism work together to realize the spatial reallocation of innovation factors through the optimization of science and technology expenditure structure.

Hypothesis 2: Digital technology innovation can indirectly promote the manufacturing industry agglomeration through science and technology expenditure.

3.2.2 Analysis of the Mediating Role of Internet Penetration

Digital technology innovation indirectly promotes the agglomeration of manufacturing industry by expanding the scale of network access and enhancing the efficiency of information interaction. Based on the theory of network externality, the development of digital technology forces the upgrading of regional Internet infrastructure. The increase of its popularity significantly reduces the cost of information transmission and collaboration, prompting enterprises to break through geographical boundaries to achieve remote supply chain collaboration, forming a composite form of "virtual agglomeration" and "physical cluster". According to the principle of economies of scale in New economic geography, regions with high Internet penetration can integrate dispersed market demand through online platforms and attract manufacturing enterprises to concentrate in the region to obtain scale effects. At the same time, the extensive penetration of the Internet accelerates the diffusion of technical knowledge in the industrial chain, strengthens the advantages of regional specialization and forms the agglomeration viscosity of "technology-market" two-way locking. In this process, China's "broadband China" strategy and new infrastructure construction policies provide institutional guarantees for Internet popularization. Enterprises rely on the network environment with high penetration rate to optimize cross-regional resource scheduling capabilities, and further promote the manufacturing cluster ecology with digital hub as the core and multi-level linkage.

Hypothesis 3: Digital technology innovation can indirectly promote the agglomeration level of China's

manufacturing industry by improving the regional Internet penetration rate.

4. Research Design

4.1 Model Construction

In order to explore the impact of digital technology innovation on manufacturing industry agglomeration, this paper adds two-way fixed effect to solve the problem of missing variables. The benchmark regression model constructed is as follows:

$$agg_{it} = \alpha_0 + \alpha_1 digital_{it} + \alpha_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where, and represent region and time respectively, represents the manufacturing industry agglomeration, represents digital technology innovation, represents control variables, and are fixed effects, and represents the random error term. In the above formula, is the estimated coefficient concerned by the paper. If it is positive and significant, it means that digital technology innovation promotes the improvement of manufacturing industry agglomeration level.

Further, this paper introduces intermediary variables to examine the internal mechanism of digital technology innovation enabling manufacturing industry agglomeration level from the aspects of technology level and Internet penetration rate. The mediation effect model is set as follow:

$$agg_{it} = \alpha_0 + \beta_1 digital_{it} + \alpha_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$$M_{it} = \alpha_0 + \beta_2 digital_{it} + \alpha_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (3)$$

$$agg_{it} = \alpha_0 + \beta_3 digital_{it} + \beta_4 M_{it} + \alpha_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (4)$$

4.2 Variable Choice and Data Description

4.2.1 Explained Variable

The explained variable was manufacturing industry agglomeration (^{agg}). Referring to the research of Wu et al. (2018), this paper takes HOOVER index as an indicator to measure the level of industrial agglomeration, and its calculation method is as follows:

$$agg_i = (e_{ij}/e_i) / (E_{kj}/E_k) \quad (5)$$

where, represents the level of industrial agglomeration, represents the number of employments in the manufacturing industry in region i, and represents the number of employments in all industries in region i. indicates the number of people employed in manufacturing in the country, and indicates the total number of people employed in the country.

4.2.2 Primary Explanatory Variable

The core explanatory variable is digital technology innovation ($digital$). Based on the research of Sun et al. (2022), this paper uses innovation output, and patent output is a widely recognized innovation indicator. Therefore, the volume of digital-related patent grants in a region is used to measure the level of digital innovation in a region. Because the interval value is too large, natural logarithm processing is carried out to facilitate calibration.

4.2.3 Mediating Variable

Science and Technology expenditure Level (tec). Consider that higher spending on science and technology tends to encourage companies to invest more in carbon-neutral technological innovation. This paper draws on the practice of Cao and Su (2023) to measure the ratio of science and technology expenditure to the expenditure in the general budget of local finance. In terms of Internet penetration rate ($inter$), this paper refers to the index system constructed by Huang et al. (2019), and adopts the total amount of telecom services per capita as the core proxy variable.

4.2.4 Control Variables

The control variables selected are as follows: The industrialization level ($manu$), which is measured by the ratio of added secondary industry to GDP with reference to the Xiong and Wang (2024); Service level ($serv$), based on the study of Xiong and Wang (2024), is measured by the ratio of value-added of tertiary industry to GDP. Education expenditure level (edu), this paper refers to the study of Lin et al. (2022), and uses education expenditure/local finance expenditure to express; Population density (pop). This paper refers to the study of Zhang et al. (2023) and uses the numerical representation of the population/urban area at the end of the year.

Table 1. Descriptive Statistical Results of Main Variables

Variable	N	Mean	SD	Min	p50	Max
agg	4050	0.87	0.52	0.01	0.78	4.85
digital	4050	1.35	0.93	0	1.2	4.69
manu	4050	0.46	0.11	0.06	0.46	1.25
serv	4050	0.41	0.11	0.08	0.41	1.31
pop	4050	5.77	0.93	0.68	5.95	7.88

edu	4050	0.18	0.04	0.02	0.18	0.38

5. Empirical Test

5.1 Benchmark Regression

In this paper, two-way fixed model is used to study the average effect of digital technology innovation on manufacturing industry agglomeration. The benchmark regression in this paper adopts the method of stepwise regression, and the results are shown in Table 2. It can be seen that in the process of adding control variables, the impact of digital technology innovation on manufacturing industry agglomeration is always significantly positive at the level of 1%. This means that digital technology innovation can significantly promote the agglomeration of manufacturing industries. All control variables are added to column (5), and the influence coefficient of digital technology innovation on manufacturing industry agglomeration is 0.0615. Through the analysis of the above regression model, it can be concluded that digital technology innovation has a significant promoting effect on the manufacturing industry agglomeration, which verifies hypothesis 1.

The influence coefficient of industrialization level is 0.526. This may be because the improvement of industrialization level significantly reduces the cost of manufacturing production factors and transaction costs by improving infrastructure, strengthening economies of scale and deepening industrial chain synergy, thus positively driving industrial spatial agglomeration. The influence coefficient of population density is significantly positive. High population density forms large-scale consumer demand, attracts manufacturing enterprises to locate nearby to reduce transportation costs, and promotes enterprises to dilute fixed costs through scale production, enhancing regional attractiveness.

Table 2. Benchmark Regression Results

	(1)	(2)	(3)	(4)	(5)
	agg	agg	agg	agg	agg
digital	0.0330***	0.0677***	0.0641***	0.0638***	0.0615***
	(3.91)	(6.81)	(5.73)	(5.71)	(5.45)
manu		0.489***	0.532***	0.521***	0.526***
		(6.52)	(5.48)	(5.37)	(5.42)
serv			0.0717	0.0700	0.0582
			(0.69)	(0.68)	(0.56)
pop				0.0849***	0.0859***
				(3.11)	(3.15)
edu					-0.297
					(-1.58)

_cons	0.829***	0.556***	0.511***	0.0271	0.0797
	(68.44)	(12.77)	(6.57)	(0.16)	(0.45)
N	4050	4050	4050	4050	4050
R2	0.004	0.015	0.015	0.018	0.018

Note. * P <0. 1, * * P <0. 05, * * * P <0. 01; standard errors are robust and shown in parentheses. These tables are identical to each other.

5.2 Mechanism Test

5.2.1 Expenditure Level of Science and Technology

In column (1), the influence coefficient is positive. Column (2) shows the coefficient of digital technology innovation and science and technology expenditure level are also positive. It shows that science and technology expenditure has a mediating effect of digital technology innovation on manufacturing industry agglomeration, thus verifying hypothesis 2. For one thing, science and technology expenditure transforms digital technology innovation from theoretical achievements to landing technical tools through targeted investment, directly lowering the threshold of enterprise technology application and promoting the large-scale diffusion of technology. For another thing, constant investment in technology communicates a policy message that the area is long-term supportive of digitization. Enhance enterprises' confidence in technology iteration and the stability of the industrial chain, and attract supporting service providers and capital to gather in the core region. Finally, the spatial stickiness of manufacturing industry is strengthened through technology dividend and economies of scale.

5.2.2 Internet Penetration

In column (3) of Table 3, the influence coefficient of digital technology innovation on regional Internet penetration rate is significantly positive. Column (4) adds the Internet penetration rate to the original baseline regression. In the regression results, the coefficient of digital technology innovation and the coefficient of regional Internet penetration are significantly positive. It shows that the regional Internet penetration rate plays a part of the mediating effect of digital technology innovation on the manufacturing industry agglomeration, thus verifying hypothesis 3. On the one hand, the high Internet penetration rate breaks the information barrier, promotes the cross-regional penetration and application of digital technology, reduces the cost of technology adoption for enterprises, and drives the spread of technology dividends to the entire manufacturing industry chain. On the other hand, Internet infrastructure improves the efficiency of information transmission, promotes the accurate matching of labor, capital and data elements, and supports manufacturing enterprises to achieve geographic concentration of supply chains through cloud collaboration and intelligent scheduling.

Table 3. Mechanism Test Results

	(1)	(2)	(3)	(4)
	tec	agg	inter	agg
digital	0.00496***	0.0400**	0.0464***	0.0465**
	(7.96)	(2.13)	(2.78)	(2.49)
tec		1.720***		
		(3.53)		
inter				0.0433**
				(2.37)
manu	0.00823**	0.573***	0.338***	0.572***
	(2.42)	(5.62)	(3.71)	(5.61)
serv	0.00218	0.0291	-0.418***	0.0509
	(0.58)	(0.26)	(-4.16)	(0.45)
pop	0.000532	0.0910***	-0.000459	0.0919***
	(0.58)	(3.33)	(-0.02)	(3.36)
edu	0.0336***	-0.403*	0.0713	-0.348*
	(4.89)	(-1.95)	(0.39)	(-1.69)
_cons	-0.00437	0.0726	0.0253	0.0640
	(-0.73)	(0.41)	(0.16)	(0.36)
N	4050	4050	4050	4050
R2	0.108	0.028	0.392	0.026

5.3 Dealing with Endogenous Problems

There may be a mutual causal relationship between digital technology innovation and manufacturing industry agglomeration. That is, cities with higher concentration of manufacturing industries are more inclined to develop digital technologies. The increasing concentration of manufacturing industries may be the cause rather than the effect of the development of digital technologies. Therefore, this paper adopts hysteresis test to rule out endogeneity problem. The impact of digital technology innovation on manufacturing industry agglomeration may have a time lag. Therefore, three regressions of digital technology innovation are carried out respectively to test the impact of digital technology innovation in the early stage on the current manufacturing industry agglomeration. The results are shown in Table 4. It can be found that the regression coefficients of digital technology innovation on manufacturing industry agglomeration are significantly positive, and the regression results are still robust.

Table 4. Endogeneity Test

	(1)	(2)	(3)
	agg	agg	agg
L.digital	0.0644***		
	(5.15)		
L2.digital		0.0755***	
		(5.46)	
L3.digital			0.0820***
			(5.46)
manu	0.476***	0.451***	0.443***
	(4.71)	(4.32)	(4.11)
serv	0.0180	-0.0506	-0.108
	(0.17)	(-0.46)	(-0.96)
pop	0.0784***	0.0720**	0.0683**
	(2.82)	(2.54)	(2.36)
edu	-0.368*	-0.577**	-0.682***
	(-1.75)	(-2.54)	(-2.78)
_cons	0.176	0.281	0.348*
	(0.97)	(1.51)	(1.81)
N	3780	3510	3240
R2	0.016	0.017	0.018

6. Conclusions and Prospects

Based on two aspects of science and technology expenditure level and regional Internet penetration rate, this paper estimates the level of manufacturing industry agglomeration in 270 cities in China. The results show that: (1) Digital technology innovation can promote manufacturing industry agglomeration. (2) In terms of impact mechanism, digital technology innovation can promote the level of manufacturing industry agglomeration by increasing the level of science and technology expenditure and regional Internet penetration.

This paper proposes the following policy implications:

First, in order to fully release the driving efficiency of digital technology innovation on manufacturing agglomeration, it is necessary to build a multi-level policy support system. First, strengthen the coordinated layout of digital infrastructure construction and technology research and development investment, prioritize the deployment of new infrastructure in areas with weak industrial infrastructure, and improve technology diffusion channels. Second, the implementation of differentiated regional digital transformation strategy, the eastern region focuses on the construction of high-end technology

ecology. The central and western regions rely on resource endowments to undertake technology spillover and narrow the regional "digital divide". Third, improve the market-based allocation and sharing mechanism of data elements, promote cross-regional and cross-industry data interconnection, and reduce the cost of industrial cluster collaboration. Fourth, establish a dynamic monitoring, assessment and risk early warning system to prevent regional imbalances caused by excessive technology agglomeration, and promote the organic unity of efficiency and fairness in the spatial distribution of innovation dividends.

Second, to strengthen the transmission efficiency of digital technology innovation driving manufacturing agglomeration through science and technology expenditure, it's necessary to build a three-in-one policy framework of "input-configuration-transformation". First, increase government-guided science and technology expenditure, focus on basic research, generic technology research and development, and lower the threshold for technology commercialization. Second, optimize science and technology expenditure, establish a central-local fiscal coordination mechanism, and target transfer payments to the central and western technology receiving areas, so as to solve the expenditure imbalance of "heavy eastern and light central and western". Third, improve the performance evaluation and dynamic adjustment mechanism of science and technology expenditure. To improve the degree of industrial agglomeration as the core index, the implementation of full cycle management. Fourth, promote the deep integration of science and technology expenditure and collaborative innovation of the industrial chain, and guide funds to flow to the common technology platform of the manufacturing cluster, the joint laboratory of production, university and research. Accelerating the penetration of technological achievements into industrial clusters; Fifth, strengthen the coordination of science and technology financial policies, and leverage social capital participation through risk compensation, discount loans and other tools. Form a diversified investment pattern of "financial input as traction and market capital as the main body".

Third, in order to maximize the transmission efficiency of digital technology innovation to promote manufacturing industry agglomeration through Internet penetration, it is necessary to build a "network foundation - collaborative governance - ecological empowerment" policy system. First, give priority to the construction of new digital infrastructure, focus on strengthening the layout of the underlying architecture such as edge computing nodes and industrial Internet platforms, and improve the carrying capacity and coverage depth of the network; Second, implement the regional Internet collaborative upgrade plan, establish a cross-administrative digital infrastructure co-construction and sharing mechanism, and break the regional barriers in the distribution of network resources; Third, deepen the network resource sharing mechanism of the manufacturing industry, promote cloud connectivity and data interoperability in design, production, logistics and other links, and release network synergies; Fourth, establish a dynamic monitoring and feedback system for Internet efficiency, evaluate the input-output ratio of network resources based on manufacturing agglomeration efficiency, and optimize the priority of resource allocation; Fifth, strengthen network security and data governance guarantees,

build an industrial cluster-level data security protection system, reduce enterprise access risks, and enhance the foundation of network trust.

The research has the following limitations and improvement directions: Due to the limitation of data acquisition conditions, the sample data up to 2022 was used in this study. The failure to dynamically capture the real-time impact of the latest developments in the digital economy on manufacturing clusters. The data source will be continuously updated to enhance the timeliness of the conclusion. At the same time, current research mainly focuses on the mediating effect between technology spending and Internet penetration. The adjustment mechanism of key variables such as industrial structure optimization and digital skill talent distribution has not been deeply analyzed, and multi-source heterogeneous data is proposed to build a moderated intermediary effect model. From the "digital technology innovation - industrial structure upgrading - agglomeration effect enhancement" chain transmission path deepening mechanism analysis, to provide more granular theoretical support for policy making.

References

Cao, X., & Su, X.E. (2023). Has the carbon emissions trading pilot policy promoted carbon neutrality technology innovation? *China Population, Resources and Environment*, *33*(07), 94-104.

Dong, L., Li, W.R., Chen, Z., et al. (2024). How does digital finance affect manufacturing industrial agglomeration?—Analysis of heterogeneous impacts across different urban agglomerations. *Financial Economy*, (08), 67-78.

Hou, M. Y. (2024). *Research on the impact of high-speed transportation on manufacturing industrial agglomeration* (Doctoral dissertation). Shandong Jiaotong University.

Huang, Q. H., Yu, Y. Z., & Zhang, S. L. (2019). Internet development and manufacturing productivity improvement: Internal mechanism and China's experience. *China Industrial Economics*, (08), 5-23.

Li, X. M. (2025). Research on the impact of digital technology innovation on the high-quality development of state-owned enterprises. *Market Modernization*, (06), 122-127.

Li, Z., Duan, S., & Sun, T. (2019). How does manufacturing industrial agglomeration affect the ecological environment—Based on a dual intermediary model of green technology innovation and foreign direct investment. *Science & Technology Progress and Policy*, *36*(06), 51-57.

Lin, K., Dong, P.F., & Hu, L. (2022). Does industrial transfer promote high-quality regional economic development?—Evidence from national-level industrial transfer demonstration zones. *Management Modernization*, *42*(03), 17-23.

Liu, Y., Liu, N., & Huo, Y. (2025). Impact of digital technology innovation on carbon emission reduction and energy rebound: Evidence from the Chinese firm level. *Energy*, *320*, 135187. https://doi.org/10.1016/j.energy.2025.135187

Lv, K.Y., Liang, X.C., & Tang, Z.D. (2025). Digital technology innovation empowers Chinese

modernization. *Shanghai Journal of Economics*, (02), 5-16.

Ma, Q. (2025). Digital technology empowers regional innovation capability improvement: Theoretical mechanism and empirical test. *Technology Economics and Management Research*, (02), 97-102.

Ma, R., & Lin, B. (2025). The impact of digital technology innovation on energy-saving and emission reduction based on the urban innovation environment. *Journal of Environmental Management*, *375*, 124176. https://doi.org/10.1016/j.jenvman.2025.124176

Maimaiti, S., Chang, Y.L., & Wumaierjiang, A. (2023). Manufacturing industrial agglomeration, environmental regulation, and high-quality economic development. *Statistics and Decision*, *39*(09), 125-130.

Shi, W.X., & Wu, W. (2020). Research on the impact of foreign direct investment on manufacturing industrial agglomeration—Taking Jiangsu Province's manufacturing industry as an example. *Macroeconomic Research*, (10), 58-70.

Shi, Z. M., & Du, L. (2022). An empirical study on the impact of industrial internet platforms on industrial integration. *Science & Technology Progress and Policy*, *39*(19), 59-68.

Sun, D. M., Hu, S. M., Zhu, T. Y., et al. (2025). How do industrial internet platforms drive the development of new quality productivity—Based on the perspective of data elements. *Science & Technology Progress and Policy*, *42*(03), 38-49.

Sun, Y., Zhang, S. H., Zhao, T. Y. et al. (2022). The impact of digital technology innovation on industrial structure upgrading and its spatial effects—Taking the Yangtze River Economic Belt as an example. *Soft Science*, *36*(10), 9-16.

Wang, D., & Li, X. (2025). The effect and mechanism of digital technology innovation driving the efficiency improvement of circulation enterprise supply chains. *Commercial Economic Research*, (06), 147-150.

Wang, F. B., Liu, S., & Zhong, J. (2025). Digital technology innovation empowers enterprise export resilience: Based on the perspective of product switching and quality improvement. *Economic System Reform*, (02), 21-29.

Wu, J. Q., He, W., Chu, D. P., et al. (2018). Industrial agglomeration and multi-dimensional urbanization heterogeneity. *China Population, Resources and Environment*, (05), 105-114.

Wu, X. H., & Yang, H. X. (2004). An empirical study on industrial agglomeration in China's manufacturing industry. *China Industrial Economics*, (10), 36-43.

Xiao, Y., Duan, Y., Zhou, H., et al. (2025). Has digital technology innovation improved urban total factor energy efficiency?—Evidence from 282 prefecture-level cities in China. *Journal of Environmental Management*, *378*, 124784. https://doi.org/10.1016/j.jenvman.2025.124784

Xiong, B., & Wang, Z.W. (2024). Research on the impact of the "dual pilot" policy of the digital economy on entrepreneurial activity—From the perspective of the synergy between a proactive government and an effective market. *Modern Finance and Economics (Journal of Tianjin University of Finance and Economics)*, *44*(06), 36-53.

Zhang, H., Hu, J., Hu, M. J., et al. (2023). Can the establishment of national-level industrial transfer demonstration zones promote green development? *Science & Technology Progress and Policy*, *40*(20), 65-75.

Zhang, L. H., Ji, T. S., & Fu, Z. Y. (2023). Research on the impact of manufacturing industrial agglomeration on environmental pollution. *Journal of North China University of Technology (Social Science Edition)*, *23*(04), 25-33.

Zhou, P.F., Shen, Y., & Zhu, X.L. (2021). The impact of manufacturing industrial agglomeration on urban green economic efficiency: Mechanism, measurement, and path. *Urban Development Studies*, *28*(03), 92-99.

Zhu, Q. Q., & Li, J. Y. (2025). Research on the impact of digital technology innovation on the green total factor productivity of manufacturing enterprises. *Coal Economic Research*, *45*(03), 113-123.