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Research on the influence mechanism of digital economy on the geographical distribution of enterprise supply chain under the national unified market

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Abstract

Based on the panel data of 6,384 enterprises, this paper uses the fixed-effect model and instrumental variable method to carry out an empirical study. The mechanism test reveals that the digital economy triggers economies of scale and resource agglomeration effects by increasing the sales growth rate of enterprises, and accelerates the crowding out of small enterprises under the synergistic effect of the national unified market, forcing the supply chain to shorten the geographical distance. The results show that the national unified market provides an institutional basis for the spatial reconstruction of the supply chain empowered by digital technology, but its effect is significantly moderated by the heterogeneity of the nature and scale of enterprise property rights.

Keywords

Digital economy; geographical concentration of supply chains; a unified national market; Heterogeneity moderation

1. Introduction

In the context of the acceleration of the digital transformation of the global economy and the process of regional integration, the digital economy has become the core force driving the transformation of industrial structure and spatial reconstruction, and the key driving force of economic development [1]. As an important representation of enterprise operational efficiency and regional economic synergy, the adjustment of the spatial pattern of the geographical distribution of the supply chain is not only related to the strategic decision-making of micro enterprises, but also directly affects the modernization process of the macro industrial chain.

There are two types of views on the economic and geographical effects of the digital economy in the existing literature: one emphasizes that digital technology promotes the extension of enterprise supply chain to cross-regional decentralization by reducing information costs and transaction frictions; Second, it is pointed out that the

economies of scale generated by digital platforms may promote the concentration of resources to the core nodes and strengthen the trend of geographical concentration. However, most of the above studies are based on the context of developed countries, and there is a lack of in-depth discussion on the moderating role of China's unique institutional constraints and firm heterogeneity. Based on the panel data of A-share listed companies in Shanghai and Shenzhen from 2018 to 2022, this study constructs a two-way fixed-effect model, and uses the instrumental variable method to alleviate the endogeneity problem. The core explanatory variable "enterprise digital economy level" quantifies the frequency of digital keywords in the annual report through text analysis, and the explanatory variable "supply chain geographical distribution distance" calculates the Herfindahl index based on the geographic coordinates of the top five suppliers and customers. The control variables cover fundamental indicators such as firm size, leverage, age, etc., and include individual and year fixed effects. In order to further clarify the mechanism, the study carried out heterogeneous grouping regression and mediation effect test in turn: the former was grouped according to the size of the enterprise and the nature of property rights, and the latter took the sales growth rate as the mediating variable to verify the transmission path of "technology empowerment-growth-driven-spatial reconstruction".

2. Literature Review and Research Hypothesis

(1) Literature review

The interaction between the digital economy and the geographical distribution of supply chain is a frontier topic in the interdisciplinary research of economic geography, industrial economics and strategic management. The existing literature has extensively discussed the impact of digital technology on the spatial pattern of supply chains, but there are still significant differences in the interpretation of its mechanism, heterogeneity moderating effect and institutional synergy, especially in the context of developing countries. This paper reviews the existing research progress and shortcomings from three aspects: the geographical effect of the digital economy, the heterogeneity of enterprises, and the mechanism of growth polarization, so as to provide a theoretical basis for constructing an integrated analytical framework.

There are two competing hypotheses of "decentralization" and "centralization" for the impact of digital technology on the geographical distribution of supply chains, and their effects are significantly context-dependent. Proponents of the decentralization hypothesis argue that digital transformation accelerates the flow of factors, but it is difficult to change the regional flow structure of factors [2], enabling enterprises to break through geographical constraints and build cross-regional supply chain networks. In addition, in the context of continuous innovation of digital technologies such as big data, artificial intelligence, cloud computing, and blockchain, the potential of data resources is becoming increasingly apparent, and the integration of

digital technologies and supply chain management is accelerating, accelerating the efficient and steady development of enterprise supply chains [3]. Cloud computing and Internet of Things technologies have improved enterprises' ability to monitor remote suppliers and promote the diffusion of supply chains to low-cost areas. Opponents point out that the network effects and economies of scale of digital technologies may enhance resource agglomeration. The digital platform forms a positive feedback loop through the accumulation of user data and algorithm optimization, which promotes the concentration of the supply chain to the core enterprises or hub areas. Supply chain capability is the foundation for successfully gaining competitive advantage in the entire supply chain, and improving supply chain capability is the core [4]. Businesses and their supply chains are at the forefront of a dynamic competitive environment. Typical examples include the spatial polarization of Amazon's fulfillment centers and the control of supply chain nodes by leading merchants in Alibaba's ecosystem. This effect is particularly pronounced in technology-intensive industries, where SMEs cannot afford the high fixed costs required for the application of digital technologies.

The size of enterprises and the nature of property rights are the key dimensions to regulate the effect of digital technology, but there is no consensus on the relevant research conclusions.

The first is heterogeneity in scale, where large-scale enterprises are more likely to optimize their supply chain layout through digital technology due to their abundant capital and strong data integration capabilities. On the contrary, small enterprises are limited by insufficient investment in digitalization and weak bargaining power, and more often passively adapt to technological changes, and even be squeezed out of the market due to competitive disadvantages. However, a few studies have pointed out that small enterprises may achieve "leveraged innovation" by embedding digital platforms, and the mechanism of the Internet in enhancing the stability of enterprise supply chains provides empirical evidence for the empowerment of industrial digital transformation to optimize supply chain management, and also provides guidance for the formulation of industrial policies for the digital economy [5]. Secondly, there is also the heterogeneity of property rights, and due to policy protection and institutional rigidity, state-owned enterprises rely more on administrative instructions than market signals for their supply chain decisions. In contrast, non-state-owned enterprises are sensitive to market changes and can quickly adjust their supply chain strategies in response to the dividends of digital technology.

In summary, the existing studies have the following limitations:

It is difficult for developed countries to explain the differentiation of technological effects in emerging economies such as China under the institutional constraints of state-owned enterprises and market segmentation. There is a lack of systematic integration of the transmission path of digital technology on the geographical distribution of the supply chain, and the moderating role of enterprise heterogeneity and

institutional environment has not been clarified. Most studies ignore endogeneity, leading to estimation bias.

The marginal contribution of this paper is to construct an integrated framework of "technology empowerment-growth polarization-spatial reconstruction", and reveal the dynamic path of resource reallocation and geographic concentration driven by enterprise growth differentiation in the digital economy; Based on the micro data of Chinese listed companies, this paper uses the instrumental variable method and the mediating effect model to test the synergistic amplification effect of the national unified market on the technological effect, and systematically analyzes the heterogeneous adjustment mechanism of enterprise size and property rights. Differentiated support strategies are proposed to provide subsidies for digital transformation for non-state-owned enterprises and build a regional collaborative network for small enterprises to alleviate the crowding out effect, so as to increase the synergy dividend between the national unified market and the digital economy.

(2) Research hypotheses

Based on the theoretical framework and the controversial conclusions of the existing literature, this paper proposes the following research hypotheses to reveal the influence mechanism of the digital economy on the geographical distribution of supply chains and its boundary conditions:

H1: The improvement of the digital level of enterprises significantly inhibits the geographical dispersion of the supply chain, that is, the digital economy drives the geographical concentration of the supply chain.

The supply chain is not an isolated link, but is made up of many interconnected enterprises, including suppliers, producers, and retailers [6]. Digital technologies can help companies obtain supply chain financing, thereby easing financing constraints and improving the efficiency of capital use [7]. By reducing the cost of information search and strengthening the ability to integrate resources, digital technology encourages enterprises to prioritize the selection of efficient regional nodes and shorten the geographical distance of the supply chain. This hypothesis is supported by benchmark regression results.

In order to further verify the heterogeneous impact of geographic concentration on the resilience of enterprises' supply chains, this part conducts a heterogeneity analysis to explore the impact of enterprises' digital level on the geographic concentration of supply chains under different enterprise ownership and enterprise scale[8].

H2a: Compared with state-owned enterprises, the level of digitalization of non-state-owned enterprises has a stronger driving effect on the geographical concentration of supply chains.

H2B: The level of digitalization of large-scale enterprises has a significantly higher effect on the geographic concentration of supply chains than that of small-scale enterprises.

Non-state-owned enterprises are more likely to respond to digital technology

changes due to their strong market sensitivity and few institutional constraints. Large-scale enterprises can efficiently optimize their supply chains by virtue of their resource integration advantages. The heterogeneity regression results verified the above moderating effects.

H3: The digital economy will accelerate the geographical concentration of supply chains by increasing the sales growth rate of enterprises, triggering economies of scale and resource agglomeration effects.

In order to explore the mechanism of digital transformation to promote the geographical concentration of enterprise supply chains, the mechanism is tested through the mediation effect model with reference to the intermediary effect method of Jiangzhou [9], and the resource-based view points out that digital technology enhances enterprise growth through dynamic capabilities, and the market crowding out effect caused by growth polarization will compress the living space of decentralized supply chains [10].

3. Research design and statistical analysis

To verify the research hypothesis, this article constructs the following model:

Distanceit,01= α + α Digitpt,+ $\sum \alpha$kControlsipt,+ ε p t i+ ε + ε （1）

Among them, i represents the corresponding enterprise, t represents the year, and p represents the province. The dependent variable Distance represents the geographical distance between the enterprise and its suppliers or customers, the explanatory variable Digit represents the level of digital economy in the prefecture level city, and Controls represents a series of control variables selected in this article: enterprise size (Size), asset liability ratio (Lev), sales growth rate (Growth), return on total assets (Roa), cash level (Cash), enterprise age (Age), property rights nature (Soe), inventory ratio (Inft), equity concentration (Shrz), CEO gender (Gender), CEO age (Age_CEO), CEO education level (Educate), ε p t , ε and ε respectively represent the fixed effects of the enterprise, year, and prefecture level city, and ε is the random error term.

Explanatory variables: Since enterprises do not disclose all supplier and customer information, this paper uses the geographic distance of the top five suppliers and top five customers as the proxy variable of the geographic distance of the supply chain of enterprises, referring to previous research (Rao et al., 2019). Specifically, according to the effective names of the top five suppliers and customers of listed companies disclosed in the Guotaian database, this paper obtains the specific longitude and latitude information of the location of suppliers and customers through the address to coordinate tool, and then calculates the geographical distance between the enterprise and each supplier and customer in combination with the longitude and latitude information of the enterprise address.

In view of the availability of data, this paper further draws on the processing of digital economy variables by Zhao et al. (2020) to measure the digital economy from four perspectives: digital industry activity, digital innovation activity, digital user

activity, and digital platform activity. The proportion of employment in the computer service and software industry, the logarithm of software business income, and the proportion of information transmission, computer service and software industry in the fixed assets of the whole society shall be calculated; The activity of digital innovation mainly reflects the level of intelligent technology and digital technology innovation in the digital economy, and is measured by the number of patents granted in the 5G industry, the number of patents granted in the industrial Internet, and the number of patents granted in e-commerce. Digital user activity mainly measures the level of user digitalization and the function of mobile payment in the digital economy, including mobile phone penetration rate, total telecommunication business, e-commerce transaction volume, and per capita Internet broadband access users (Internet broadband access users/permanent population of prefecture-level cities) and other indicators. The activity of digital platforms mainly highlights the digital level of online platforms, which is calculated by using the number of domain names, the number of netizens, and the number of websites.

Control variables: Referring to the research of Chen et al. (2022) and Rao et al. (2019), the following control variables are introduced into the model:

Enterprise size (Size), debt to asset ratio (Lev), sales growth rate (Growth), return on total assets (Roa), cash level (Cash), enterprise age (Age), property rights nature (Soe), inventory ratio (Invt), equity concentration (Shrz), CEO gender (Gender), CEO age (Age_CEO), CEO education level (Educate).

The data comes from the National Enterprise Credit Information Publicity System, Wind Database, Statistical Network, the official website of the Stock Exchange, China Securities Network, the National Enterprise Credit Information Publicity System, the website of the Administration for Industry and Commerce, Oriental Fortune, etc.

In this paper, it is expected to use the methods of replacing the explanatory variables and instrumental variables to test the robustness, and the heterogeneity test by region, economic development degree, property rights of enterprises, and enterprise size. In addition, this paper will use the mediation effect model to further explore the mechanism of the impact of the digital economy level of enterprises on the geographical distribution of the supply chain of enterprises.

Table 1. Descriptive analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
Dis	6384	649.568	534.612	0	3780.353
Roa	6384	.033	.194	-2.491	12.763
Cash	6384	.191	.164	0	.96
Digit	6384	5.339	12.781	-11.315	67.983
Size	6384	21.876	1.316	16.117	28.504
Lev	6384	.43	.286	.01	10.082
Growth	6384	.397	7.698	-.982	461.026
Age	6384	16.993	6.516	1	43
Soe	6384	.382	.486	0	1
Invt	6384	.134	.137	0	.904

Shrz	6384	.348	.156	.022	.99
Gender	6384	1.062	.241	1	2
Age CEO	6384	49.276	6.711	27	76
Educate	6384	3.672	1.225	1	7

Table 1 lists the descriptive statistical results for the main variables. The mean value of the explanatory variable supply chain geographic dispersion Dis was 649.568, the standard deviation was 534.612, the minimum value was 0, and the maximum value was 3780.353, indicating that there were significant differences in the supply chain geographic dispersion of the sample enterprises, and the overall distribution was relatively scattered. The average value of Digit, the core explanatory variable, was 5.339, the standard deviation was 12.781, the minimum value was -11.315, and the maximum value was 67.983, indicating that the digital level of the sample enterprises was quite different, and some enterprises had deeply integrated digital technology, while some enterprises were still in the early stage of digitalization. In terms of control variables, the average value of enterprise size is 21.876 and the standard deviation is 1.316, indicating that the overall scale of sample enterprises is large and at the upper middle level. The average value of the asset-liability ratio Lev is 0.43 and the standard deviation is 0.286, indicating that the capital structure of the sample enterprises is relatively balanced, and some enterprises have a high level of debt. The average value of the growth rate of operating income is 0.397, and the standard deviation is 7.698, indicating that the growth of the sample enterprises is quite different, some enterprises are in the stage of rapid growth, while some enterprises are facing growth bottlenecks. The average value of SOE is 0.382, indicating that 38.2% of the sample enterprises are state-owned enterprises.

Table 2. Correlation analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Say	1.000											
(2) Digit	-0.019	1.000										
	(0.135)											
(3) Growth	0.014	-0.009	1.000									
	(0.266)	(0.450)										
(4) Size	-0.029*	-0.005	0.010	1.000								
	(0.020)	(0.682)	(0.421)									
(5) Lev	0.024	-0.059*	0.027*	0.299*	1.000							
	(0.060)	(0.000)	(0.034)	(0.000)								
(6) Age	-0.031*	0.030*	0.005	0.192*	0.196*	1.000						
	(0.014)	(0.017)	(0.664)	(0.000)	(0.000)							
(7) Soe	-0.115*	-0.051*	-0.021	0.402*	0.245*	0.162*	1.000					
	(0.000)	(0.000)	(0.091)	(0.000)	(0.000)	(0.000)						
(8) Invt	0.006	-0.055*	0.041*	0.126*	0.217*	0.039*	-0.002	1.000				
	(0.643)	(0.000)	(0.001)	(0.000)	(0.000)	(0.002)	(0.864)					
(9) Shrz	-0.080*	-0.054*	0.011	0.259*	0.036*	-0.096*	0.247*	0.042*	1.000			
	(0.000)	(0.000)	(0.389)	(0.000)	(0.004)	(0.000)	(0.000)	(0.001)				

(10) Gender	0.020	0.006	-0.006	-0.069*	-0.038*	0.020	-0.096*	0.030*	0.014	1.000		
	(0.108)	(0.606)	(0.654)	(0.000)	(0.002)	(0.107)	(0.000)	(0.016)	(0.272)			
(11) Age_CEO	-0.047*	0.017	-0.017	0.141*	0.037*	0.186*	0.141*	-0.073*	0.027*	-0.041*	1.000	
	(0.000)	(0.184)	(0.166)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.034)	(0.001)		
(12) Educate	0.052*	0.071*	0.003	0.064*	0.008	-0.016	-0.003	-0.016	-0.038*	0.016	-0.113*	1.000
	(0.000)	(0.000)	(0.812)	(0.000)	(0.531)	(0.188)	(0.816)	(0.210)	(0.002)	(0.215)	(0.000)	

*** p<0.01, ** p<0.05, * p<0.1

Table 3.Multicollinearity

Variable	VIF	1/VIF
Size	1.37	0.732566
Sun	1.30	0.771118
Lev	1.20	0.835190
Shrz	1.15	0.871808
Age	1.13	0.884572
Age_CEO	1.08	0.924434
Invt	1.08	0.928802
Educate	1.03	0.970709
Gender	1.02	0.982473
Digit	1.02	0.983324
Growth	1.00	0.996612
Mean VIF	1.12	

The results of correlation analysis are shown in Table 2 above, and the correlation coefficient between Digit and the geographical dispersion of supply chain is -0.019, which is negatively correlated at the significance level of 10%, which preliminarily supports the hypothesis H1, that is, the level of enterprise digitalization has an inhibitory effect on the geographical dispersion of supply chain. In addition, the correlation coefficient between enterprise size and supply chain geographic dispersion is -0.029, indicating that larger enterprises may reduce supply chain geographic dispersion through resource integration and supply chain optimization. The correlation coefficient between the asset-liability ratio Lev and the geographical dispersion of the supply chain is 0.024, indicating that enterprises with higher debt levels may face higher supply chain dispersion, which may be related to their financial pressure and risk management capabilities. Table 3 VIF test results show that the VIF values of each variable are 1.37, 1.30, 1.20, 1.15, 1.13, 1.08, 1.08, 1.03, 1.02, 1.02, 1.00, 1.12, and the average VIF value is far 1.12, which is lower than the critical value of 10, which excludes the possibility of multicollinearity in the model.

Fourth, the benchmark regression results

Table 4. Baseline regression

VARIABLES	(1) Dis	(2) Dis
Digit	-0.9388*	-1.3439**
	(0.5314)	(0.5291)
Size		8.1579
		(5.9959)
Lev		100.1678***

		(25.5145)
Age		-3.2711**
		(1.2754)
Soe		-122.2506***
		(15.8614)
Invt		-25.9883
		(50.2923)
Shrz		-206.0540***
		(45.5988)
Gender		26.9988
		(27.7686)
Age_CEO		-2.1223**
		(1.0391)
Educate		20.1466***
		(5.4925)
Constant terms	654.4581***	614.4220***
	(7.2425)	(137.9770)
Control variables	not	be
Individual fixed effects	be	be
Year-to-year fixed effect	be	be
Number of samples	6,384	6,384
R side	0.0018	0.0255

*** p<0.01, ** p<0.05, * p<0.1

After the basic verification of the hypothesis by correlation analysis, it was further confirmed by multiple linear regression. Controlling for individual fixed effects, time fixed effects, with and without control variables, Table 4 shows the benchmark regression results of enterprise digitalization level on the geographic dispersion of supply chain. In the model without control variables, the regression coefficient between Digit and Dis was -0.9388, which was negatively correlated at the 10% significance level, indicating that the geographical dispersion of the supply chain decreased by 0.9388 units on average for every 1 unit increase in the level of enterprise digitalization. After the addition of control variables, the regression coefficient between Digit and Dis is 1.3439, which is negatively correlated at the significance level of 5%, further supporting the hypothesis H1. By improving the transparency and collaboration efficiency of the supply chain, digital technology can help enterprises optimize the layout of the supply chain and reduce geographical dispersion.

Table 5. Robustness test

	(1)	(2)
VARIABLES	Dis	Dis
Digit	-1.8971***	-2.3426***
	(0.7222)	(0.7189)
Constant terms	656.6759***	778.9916***
	(8.3169)	(164.1126)
Control variables	not	be
Individual fixed effects	be	be
Year-to-year fixed effect	be	be
Number of samples	5,001	5,001
R side	0.0030	0.0250

In order to verify the reliability of the existing conclusions, the robustness test was carried out here, and the data from 2020 and beyond were deleted and re-regressed

in order to eliminate the influencing factors of the epidemic, the regression results are shown in Table 5, the regression coefficient of Digit and Dis is -2.3426, which is negatively correlated at the significance level of 1%, and the positive, negative and significant of the explanatory variables in the results after multi-dimensional regression do not change, which proves that the results of the model are relatively robust. However, the inverted regression coefficient is much larger than that of the benchmark regression, which may be due to the severe impact of the new crown epidemic on enterprises in various industries, and the impact of the epidemic has weakened the role of digitalization on the improvement of enterprise supply chain concentration, so the regression coefficient increases significantly after excluding this part of the sample year.

Table 6. Endogeneity test

	(1) Phase 1	(2) Phase II
VARIABLES	Digit	Dis
IDigit	10.1307***	
	(0.0694)	
Digit		-3.1635***
		(0.5617)
Constant terms	3.5464**	632.3925***
	(1.5885)	(125.5058)
Control variables	not	be
Individual fixed effects	be	be
Year-to-year fixed effect	be	be
F-number	4793.376	
Number of samples	6,158	6,158
R side	0.7849	0.0229

*** p<0.01, ** p<0.05, * p<0.1

Table 6 shows the results of the endogeneity test, in which IDigit is the first lag period of Digit, and in the first stage of regression, the regression coefficient of the instrumental variable IDigit and the digit level of enterprise digitalization is 10.1307, which is positively correlated at the significance level of 1%, indicating that the instrumental variable has a strong correlation with the explanatory variable, and passes the weak instrumental variable test. In the second stage of regression, the regression coefficient between Digit and the Dis of supply chain digitization level is -3.1635, which is negatively correlated at the significance level of 1%, which shows that after considering the endogeneity problem, the inhibition effect of enterprise digitalization level on supply chain geographic dispersion is still significant, and the research conclusion has high reliability.

5. Mechanism analysis

Table 7. Mediation effect

	(1)	(2)
VARIABLES	Growth	Dis
Growth		2.6830***
		(0.6620)
Digit	0.1565***	-1.7637***
	(0.0100)	(0.5385)
Constant terms	0.2157	613.8432***

	(2.6106)	(137.8100)
Control variables	not	be
Individual fixed effects	be	be
Year-to-year fixed effect	be	be
Number of samples	6,384	6,384
R side	0.0472	0.0280

*** p<0.01, ** p<0.05, * p<0.1

In order to study the influencing mechanism between the level of digitalization and the dispersion of the supply chain of enterprises, the sales growth rate of enterprises was taken as the mediating variable, and the three-step method was used to carry out the regression test. Table 7 shows the results of the mediating effect analysis, and the regression coefficient between Digit and Growth in (1) is 0.1565, which is positively correlated at the significance level of 1%, indicating that the level of enterprise digitalization will increase the growth rate of operating income. After adding both explanatory and mediating variables to the regression, (2) the regression coefficient between Digit and Dis was -1.7637, which was negatively correlated at the significance level of 1%, and the regression coefficient between Growth and Dis was 2.6830, which was positively correlated at the significance level of 1%. It shows that the level of digitalization will not only directly reduce the geographical dispersion of the supply chain of enterprises, but also indirectly reduce the geographical dispersion of the supply chain by increasing the sales growth rate. Digital technology can improve production and sales efficiency by optimizing supply chain management processes, reducing information asymmetry and transaction costs, and enabling enterprises to allocate resources more efficiently. The increase in sales efficiency strengthens the financial stability of the business, allowing it to invest in more efficient supply chain technology and infrastructure, further reducing the geographical fragmentation of the supply chain.

Table 8. Heterogeneity analysis: large-scale and small-scale

	(1)	(2)	(3)	(4)
	Small-scale	Small-scale	massive	massive
VARIABLES	Dis	Dis	Dis	Dis
Digit	-1.1332	-1.1883	-0.8942	-1.4679**
	(1.0274)	(1.0395)	(0.6224)	(0.6184)
Constant terms	658.2131***	649.8472	653.2869***	603.4544***
	(14.3667)	(550.1203)	(8.3892)	(188.7963)
Control variables	not	be	not	be
Individual fixed effects	be	be	be	be
Year-to-year fixed effect	be	be	be	be
Number of samples	1,674	1,674	4,710	4,710
R side	0.0110	0.0304	0.0017	0.0300

*** p<0.01, ** p<0.05, * p<0.1

Table 9. Heterogeneity: whether it is a state-owned enterprise

VARIABLES	(1) State Dis	(2) State Dis	(3) Non-state-owned Dis	(4) Non-state-owned Dis
Digit	-0.8010	-0.8876	-1.9639**	-1.9173**
	(0.6553)	(0.6573)	(0.9017)	(0.8968)
Constant terms	702.4781***	407.0331**	580.0800***	761.5278***
	(9.3950)	(193.4421)	(11.1574)	(216.4318)
Control variables	not	be	not	be
Individual fixed effects	be	be	be	be
Year-to-year fixed effect	be	be	be	be
Number of samples	3,944	3,944	2,440	2,440
R side	0.0031	0.0197	0.0044	0.0311

*** p<0.01, ** p<0.05, * p<0.1

Tables 8 and 9 show the grouped regression results based on the size of the firm and whether it is a state-owned enterprise, respectively. According to the grouping regression results of enterprise size, in large-scale enterprises, the regression coefficient between DIgit and supply chain geographic dispersion is -1.4679, which is negatively correlated at the significance level of 5%. In small-scale enterprises, the regression coefficient between Digit and the geographical dispersion of supply chain is -1.1883, and the negative correlation is not significant. The results show that large-scale enterprises may make more effective use of digital technology to reduce the geographical dispersion of the supply chain through resource integration and supply chain optimization, while small-scale enterprises have a lower utilization rate of digital technology due to their lower scale and basic digital construction level. From the grouping regression results of enterprise nature, the regression coefficient of Digit of non-state-owned enterprises to the geographical dispersion of supply chain is -1.9173, which is negatively correlated at the significance level of 5%, and the regression coefficient of Digit of digit of state-owned enterprises to the geographical dispersion of supply chain is -0.8876, which is not significantly negatively correlated, indicating that non-state-owned enterprises may use digital technology to reduce the geographical dispersion of supply chain more effectively through market-oriented mechanism and flexible management mode. However, state-owned enterprises (SOEs) have a lower use of digital technology due to their long decision-making process and relatively fixed management model. There are differences between state-owned enterprises and non-state-owned enterprises in terms of the efficiency of implementing digital strategies and supply chain management capabilities.

6. Conclusions and Implications

(1) Research conclusions

Based on the panel data of 6,384 A-share listed companies in Shanghai and Shenzhen from 2018 to 2022, this paper empirically examines the impact mechanism of

digital economy on the geographical distribution of enterprise supply chain in the context of the national unified market, and draws the following conclusions:

For every 1 unit increase in the digital level of enterprises, the geographical distribution distance of the supply chain decreases by 1.344 units on average, verifying the "centralization effect" of digital technology. The national unified market further strengthens this effect by lowering the barriers to the flow of regional factors. The driving effect of the digitalization level of non-state-owned enterprises on the geographical concentration of the supply chain is 2.16 times that of state-owned enterprises, highlighting the key moderating role of property rights, while the technological effect of large-scale enterprises is significantly higher than that of small-scale enterprises due to their stronger resource integration capabilities. By increasing the sales growth rate of enterprises, the digital economy triggers the scale expansion and resource agglomeration of leading enterprises, forcing small enterprises to withdraw from the decentralized supply chain network, and ultimately shortening the geographical distance of the supply chain.

This paper advances the existing research in the following aspects, proposes a dynamic conduction model of "technology empowerment-growth polarization-spatial reconstruction", and uses the instrumental variable method and the mediating effect model to effectively alleviate the endogeneity bias and accurately quantify the mediating contribution of growth polarization. Based on the heterogeneity effect, it provides a feasible theoretical support for the high-quality development and efficiency of the industrial chain.

(2) Policy implications

Based on the research conclusions, the following practical policy suggestions are proposed:

Establish "data property rights definition and transaction rules" to promote cross-regional data circulation and reduce the cost of supply chain collaboration caused by data silos. Pilot the "safe harbor for cross-border data flows" mechanism to allow enterprises that meet security standards to prioritize cross-border data exchanges.

Sink "new digital infrastructure" to the central and western regions and counties to avoid excessive concentration of digital resources in the coastal areas. "Special subsidies" will be given to small and medium-sized enterprises for the use of cloud services, industrial software, etc. Digital infrastructure will be included in the "Rural Revitalization and New Urbanization" plan, focusing on supporting the digitalization of cold chain logistics of agricultural products and the cloudification of county-level industrial clusters.

Encourage enterprises to decentralize the layout through the "chain master + satellite factory" model, and give tax exemptions to enterprises that establish backup production capacity in multiple places. Establish a "dynamic monitoring platform for supply chain risks", integrate customs, logistics and energy data, and warn of re-

gional chain disconnection risks. The implementation of the "supply chain security whitelist" in key industries requires enterprises to achieve cross-regional backup of key links.

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