Research on the Impact of Industry Digitization on Export Technology Complexity: Evidence from China

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Abstract. The rapid development of industrial digitization provides new opportunities for the development of China's real industry and the upgrading of export technical complexity. Based on the balanced panel data of 30 provinces in China from 2011 to 2022, this paper calculates the level of industrial digitalization in each province, and uses the fixed-effect model to discuss the effect of industrial digitalization level on the improvement of export technology complexity. The empirical findings are as follows: (1) The level of industrial digitization in China's provinces is increasing year by year and is related to the level of economic development; (2) China's industrial digitization level is unbalanced in the landing zone; (3) Industrial digitalization can promote the improvement of export technical complexity.

Keywords: Industrial digitalization, Chinese exports, Export technical complexity.

1. Introduce

Under the dual background of global economic integration and the rapid development of information technology, digital economy has become an important force to promote the transformation and upgrading of the global economy [1]. In 2023, the scale of China's digital economy will reach 53.9 trillion yuan, the scale of digital industrialization and the scale of industrial digitalization will reach 10.1 trillion yuan and 43.8 trillion yuan respectively, accounting for 18.7% and 81.3% of the digital economy, respectively. The 20-80% ratio structure of the digital economy is relatively stable, and the dominant position of industrial digitalization is very prominent [2]. As the world's second largest economy, China is actively embracing this change. More and more evidence shows that the development of digital economy, especially the acceleration of industrial digitization and the realization of deep cooperation between digital and industry, has become a new opportunity for developing countries to achieve industrial transformation and upgrading and upgrade their trade status [3].

Export technical complexity is an important index to measure the structure, technical content and international competitiveness of a country or region's export products, which comprehensively reflects the position and technology intensity of export commodities in the global value chain [4]. As a major trading country in the world, the change in the technological complexity of China's export is not only related to the optimization and upgrading of its own economic structure, but also affects the evolution of the global trade pattern [5]. However, in recent years, the momentum of technological complexity improvement of China's export products has slowed down [6], the comparative advantages of traditional labor-intensive and low-tech commodities have declined more rapidly, and the advantages of capital-intensive and high-tech commodities have not been consolidated, so the improvement of export competitiveness faces structural challenges [7]. Under the new development pattern, China wants to improve the complexity of export technology. On the one hand, it should strengthen the independent innovation of science and technology, optimize the current industrial technology route, and actively participate in the competition in the world market [8]. On the other hand, it is necessary to strengthen international cooperation, introduce advanced technologies, actively integrate into the global value chain, and enhance the position of global division of labor [9].

Industrial digitization has a significant positive impact on the technical complexity of export. Through the deep integration of modern information technology and traditional industries, industrial digitalization not only improves production efficiency and innovation ability [10], but also promotes the increase of product technical content and added value, thus directly promoting the improvement of export technical complexity [11]. Therefore, by accelerating industrial digital transformation and upgrading and transforming traditional industries, China can effectively improve the current situation of slowing down the improvement speed of export technological complexity [12].

This paper uses panel data from 30 provinces in China from 2011 to 2022 for an empirical test. Our paper finds that industrial digitalization can promote an increase in the technological complexity of exports. The possible marginal contributions of this paper are as follows: (1) the impact of industrial digitalization on the technological complexity of exports is discussed from the meso-perspective of industry level, and the existing theoretical framework is supplemented; (2) The measurement index system of industrial digital transformation is constructed with reference to relevant studies, and its promoting effect on the technological complexity of exports is tested through empirical research; (3) From the perspective of industrial digitalization, it provides new suggestions for improving the technical complexity of China's export.

The rest of this article follows. Section 2 analyzes the concept and measurement methods of industrial digitalization, and how industrial digitalization affects the complexity of export technology, and puts forward research hypotheses. Section 3 describes data sources, methods, and variable definitions. Section 4 provides empirical analysis and results. Section 5 summarizes the conclusions and significance of this study. Theory and Hypothesis

2. Theory and Hypothesis

2.1. Research on industry digitization

With the continuous progress of information and communication technology, digital economy has gradually become a research hotspot. Since Tapscott put forward the concept of digital economy in his book in 1996, industrial digitization in the digital economy has become a widely discussed and researched field, which is divided into the following two aspects:

First, research on the concept of industrial digitalization. As the main part of digital economy, industrial digitalization mainly applies digital technology in existing industries [13]. The object and subject of industrial digitalization are traditional industries with relatively low production efficiency and digital technology respectively, and the process of the subject using the object to upgrade and transform its business in an all-round, all-round Angle and whole-chain is called industrial digitalization [14].

Second, the research on the measurement of industry digitalization. Some literatures use the questionnaire data of domestic small and micro enterprises in digital transformation to measure the level of industrial digitalization [15], and some literatures use the calculation and analysis of the scale of digital economy added value to obtain the data of output value increment to measure the level of industrial digitalization [16]. A more extensive method is to use the evaluation index of industrial digitalization to measure the level of industrial digitalization [17]. Moreover, most literatures believe that there is regional imbalance in China's industrial digitalization [18].

2.2. The influence of industry figures on the technical complexity of export

The key elements of industrial digitalization are various digital technology means represented by "cloud computing, Internet of Things, blockchain", etc. Digital technology plays an important role in promoting industrial infrastructure configuration, reducing enterprise production and operation costs, forming cluster effect, and increasing the added value of export products [19]. At the same time, in the process of industrial digitalization, the application of information technology has also had a certain impact on the systematic transformation of production mode, organizational model and business model [20]. Upstream and downstream enterprises in the industrial chain can better respond to changes in market demand with the convenience of data, strengthen exchanges and cooperation with upstream and downstream enterprises, and expand new product application scenarios [21].

At the same time, industrial digitalization integrates digital technology with the real economy, which occurs in the export field with the following characteristics: First, industrial digitalization optimizes resource allocation and industrial structure, promotes digital transformation and upgrading of traditional industries, enhances industrial innovation vitality, enables reasonable and effective allocation of resources among different countries, regions and workers, accelerates technology upgrading, promotes regional or national export transformation, and further improves the technological complexity of export [22]. Second, industrial digitalization drives business model innovation, and accelerates the spatial spillover efficiency of technological innovation and technological level through digital opportunity capability, digital capability and digital collaboration capability, thus enhancing the technical complexity of export products [23]. Third, the improvement of the level of industrial digitalization not only increases the demand for highly skilled talents [24], but also improves the level of domestic human capital, thus inducing the technological upgrading of export enterprises and laying a solid foundation for improving the quality of export products [24]. Therefore, the following hypothesis is proposed.

H: Industrial digitization has played a positive role in promoting the technological complexity of exports.

3. Data and Econometric Model

3.1. Data Sources

To test our hypothesis, we used data from a sample of 30 provinces in China from 2011-2022. The original samples were processed as follows: (1) 30 provincial-level regions (except Tibet, Hong Kong, Macao and Taiwan) were selected as samples in this paper to ensure data integrity; (2) In this paper, the export data in US dollar is unified into RMB through the annual average exchange rate, and then the eight-digit HS commodity code is converted into the six-digit HS commodity code. Since the commodity code is changed every five years, the time span of this paper is 2011-2022, HS2007 code, HS2012 code, HS2017 code and HS2022 code correspond to 2011, 2012-2016, 2017-2021 and 2022 respectively. Therefore, the commodity code comparison table of the United Nations Commodity Trade Statistics website is uniformly changed into the HS2007 code version [25]. (3) This paper uses linear interpolation to fill in some missing variables; (4) In order to solve the possible heteroscedasticity phenomenon, this paper introduces the data in the form of natural logarithms except for the level of finance, regional openness, infrastructure and industrial structure among the control variables into the model. Finally, a set of balanced panel data composed of 30 provinces is obtained. The data used to calculate the technical complexity of export mainly come from the "Foreign Trade Database of China Research Network". The data of industrial digitization comes from the National Bureau of Statistics, China Science and Technology Statistical Yearbook, Peking University Digital Financial Inclusion Index Report, China Tertiary Industry Statistical Yearbook, and China Electronic Information Industry Statistical Yearbook.

3.2. Measurement of Variables

3.2.1 Dependent Variables

Export technical complexity (EXPY). To some extent, the technical complexity of export can reflect the commodity structure of a country or region, and also reflect the technical level and international status of the country or region's foreign trade. Hausmann (2007) and Rodrik (2006) first used the technological complexity of export to measure the technological content and commodity structure of a country's export products. According to their hypothesis, the technological content of export products is related to the per capita income level of the exporting country. The export technical complexity is obtained by weighted average calculation of per capita income based on the weight of the export volume of each product in the exporting country or exporting region in the total export volume [4, 26]. With reference to the calculation method of Hausmann (2007), the export technical complexity of various provinces in China is calculated by using the export statistical data of HS sixth of international trade of the National Research Network, and the export technical complexity of more than 4000 products in each province during 2011-2022 is calculated. The specific calculation method is as follows:

$$Prody_{ik}=\sum_{i}\frac{e_{ik}/e_{i}}{\sum_{i}(e_{ik}/e_{i})}\times y_{it} \quad (1)$$

Where $Prody_{ik}$ represents the export technical complexity of k products of Province i, e_{ik} represents the export volume of k products of province i, e_i represents the total export trade of province i, and y_{it} represents the actual per capita GDP of province i in t years using the consumer price index and the actual value based on the year 2000 [27]. Model (1) is used to calculate the export technical complexity of product k in province i, and then model (2) is used to calculate the export technical complexity at the provincial level:

$$EXPY_{it}=\sum_{k}\frac{e_{ik}}{e_{i}}\times Prody_{k} \quad (2)$$

3.2.2 Independent variables

Industrial Digitization (lnIDT). Industrial digitalization is an important part of digital economy and the integrated development of digital economy and industry. Therefore, this paper uses the test methods of industrial digitalization proposed by Liu Gong and Yu Mingyue (2021), Fu Weizhong and Liu Yao (2021) and combines the availability of data [3, 21]. Starting from the four first-level indicators of digital infrastructure, enterprise digitalization, digital integration and digital income, 12 second-level indicators are selected to build an industrial digitalization index system, so as to measure the overall development level of industrial digitalization in 30 provinces in China. In order to determine the importance of each index, the entropy method is used to objectively assign weights to each index, and the comprehensive evaluation index of industrial digitalization in each province is obtained. The index details are shown in Table 1, where the integration level of industrialization and informatization is calculated from the physical coupling degree formula $c=\frac{\sqrt{u_1u_2}}{u_1+u_2}$ where u_1 represents the software business income, u_2 represents the main business income of industrial enterprises above designated size, the greater the c, the better the integration degree of industrialization and informatization.

Table 1. Comprehensive evaluation index system of industrial digitalization

Primary indicator	Secondary indicator	Tertiary Indicators
Digital infrastructure	Optical cable covering	Length of long distance optical cable line
	Mobile phone penetration	Mobile phone penetration
	Computer use	Computer use per 100 people
	Network popularization	Number of broadband Internet ports per 10,000 people
Enterprise digitization	Government science and technology support	Local government expenditure on science and technology
	E-commerce enterprise	Proportion of enterprises with e-commerce transaction activities
	Enterprise website	Number of websites per 100 companies
Digital integration	Integration level of industrialization and informatization	Software revenue
		Income from main business of industrial enterprises above designated size
	Digital finance	Number Total Index of inclusive amounts
		Coverage span
		Degree of digitization
Digital income	E-commerce income	E-commerce sales

3.2.3 Control variables

Foreign Direct Investment (lnFDI). Under the global value chain division system, OFDI can directly affect the technological complexity of the region's exports. In this paper, the total investment of foreign-invested enterprises is used to measure OFDI [28]. The unit of total investment is US dollar, which is converted into RMB according to the average exchange rate of the year, and in order to eliminate the gap in dimensions, it is naturally logized [29].

Financial Level (FIN). The development of finance can promote the capital financing of enterprises and the spillover of foreign direct investment, which plays an important role in improving the technical complexity of export. In this paper, the proportion of the balance of RMB deposits and loans of financial institutions in each province to the GDP is adopted to measure the financial level of each province [8].

Regional openness level (OPEN). The increase of import can promote the diffusion of industrial technology, and the expansion of export scale can improve the labor productivity of the industry, which is conducive to the improvement of industrial digitization and the complexity of export technology. In this paper, the ratio of the total import and export volume of each province to the GDP is taken as the standard to measure the regional development level [30]. The unit of the total import and export volume is US dollar, which is converted into RMB according to the average exchange rate of the year.

Infrastructure (INST). In this paper, the number of kilometers per 100 people is measured by dividing the number of highway miles in each province by the total population at the end of the year and multiplying by 100. The more perfect the infrastructure, the more convenient the inter-regional technical communication and cooperation, which is conducive to improving the technical complexity of export [31].

Industrial structure level (IS). In this paper, the proportion of the added value of the secondary industry and the added value of the tertiary industry is adopted as the measurement standard [32]. The higher the level of industrial structure, the higher the proportion of technology and knowledge-intensive industries in the region, which is of great significance to the improvement of export technical complexity.

3.3. Model Specification

In order to explore the impact of industrial digitalization on export technology complexity, this paper builds the following bi-directional fixed effect benchmark model for provinces and individuals by referring to similar literature [33, 34]:

$$lnEXPY_{it}=a_0+\alpha_1 lnIDT_{it}+\sum\alpha_i CONTROL_{it}+u_i+\lambda_t+\varepsilon_{it} \tag{3}$$

Where $lnEXPY_{it}$ represents the technical complexity of export in t year of Province i, $lnIDT_{it}$ represents the level of industrial digitization in t year of Province i, u_i is the fixed effect of province, λ_t is the fixed effect of year, ε_{it} is the random error term, $CONTROL_{it}$ represents a series of control variables in t year of province i. Including outward direct investment (lnFDI), Financial level (FIN), regional openness level (OPEN), infrastructure level (INST), industrial structure level (IS).

4. Results and Discussion

4.1. Descriptive statistics

Table 2 shows the descriptive statistics of relevant variables of 30 provinces in China from 2011 to 2022. The maximum value of IDT is 0.8260, and the average value is 0.3889. It can be found that the distribution of industrial digitalization samples is not balanced and there are some differences. Similarly, there is a large gap between the maximum export technical complexity (EXPY) of 69800 and the minimum EXPY of 17700. In addition, this paper calculates the Person correlation coefficient between the main variables, and the results show that the correlation coefficient between industrial digitalization and export technology complexity is significantly positive, which initially confirms the theoretical expectation.

Table 2. Descriptive statistics of main variables

Variables	Mean	Standard Deviation	Median	Minimum	maximum
EXPY	39600	9044.2392	38600	17700	69800
IDT	0.3889	0.1541	0.4010	0.0687	0.8260
FDI	13300	28500	3641.9524	1.7858	292000
FIN	3.4323	1.0948	3.2075	1.6776	7.6223
OPEN	0.2718	0.2809	0.1464	0.0076	1.4638
INST	0.3953	0.2478	0.3616	0.0514	1.4739
IS	1.3572	0.7443	1.2017	0.5271	5.2440

In order to eliminate the interference of multicollinearity on the regression results, multicollinearity tests were carried out on the main variables before regression. VIF test is selected in this paper, and the test results are shown in Table 3. The results show that the VIF value of each variable is less than 4, so there is no serious multicollinearity problem between all variables.

Table 3. VIF test

Variables	VIF	1/VIF
FIN	3.59	0.2788
lnIDT	2.69	0.3715
lnFDI	2.64	0.3784
OPEN	2.64	0.3785
IS	2.63	0.3796
INST	1.95	0.5122
Mean VIF	2.69	

4.2. Industrial digitization level

Based on the above method, the industrial digitization level of each province is calculated, and the results are shown in Table 4. In general, China's industrial digitalization level shows an overall rising trend, the average value of the national industrial digitalization is only 0.1056 in 2011, and gradually rises every year after that, reaching 0.5833 in 2022. The level of industrial digitalization in all provinces has also risen steadily, indicating that with the development of time, all provinces have realized the importance of industrial digitalization and made progress in digital construction. The horizontal comparison shows that there is a correlation between the level of industrial digitalization and the level of economic development in each province. The economic development level of the eastern coastal provinces with higher economic development level is significantly higher than that of the central and western inland provinces. The industrial digitalization level of Beijing, Shanghai, Guangdong and Jiangsu, which are developed areas in the east, is far higher than that of Jilin, Ningxia, Gansu, Xinjiang and other less developed provinces in the central and western regions. The longitudinal comparison also shows that the gap in industrial digitalization among provinces is also widening year by year. In 2011, the level of industrial digitalization in Beijing was 0.0740 higher than that in Xinjiang, but in 2022, the gap between the two widened to 0.3220. There are two reasons for the above characteristics: First, the development of industrial digitalization needs economic support, and the developed economic level attracts the investment of capital and the influx of talents; Second, industrial digitalization needs to rely on certain entity enterprises, and the stronger level of industrialization in developed regions provides a good development space for the development of industrial digitalization.

Table 4. Industrial digitization level by province during 2011-2022

Provinces	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Beijing	0.1511	0.2618	0.3625	0.4175	0.5188	0.5171	0.5688	0.6441	0.6979	0.7204	0.7688	0.8198
Tianjin	0.1096	0.1848	0.2534	0.3003	0.3927	0.3758	0.3844	0.4388	0.4653	0.4873	0.5281	0.5660
Hebei Province	0.1015	0.1711	0.2506	0.2872	0.3676	0.3673	0.3886	0.4369	0.4596	0.4880	0.5132	0.5351
Shanxi	0.1114	0.1904	0.2629	0.3018	0.3878	0.3891	0.3975	0.4496	0.4622	0.4796	0.5168	0.5513
Inner Mongolia	0.1064	0.1862	0.2708	0.3259	0.4221	0.4262	0.4259	0.4464	0.4771	0.4865	0.5023	0.5650
Liaoning	0.0815	0.1570	0.2393	0.2950	0.3911	0.3625	0.3826	0.4386	0.4618	0.4727	0.5057	0.5357
Jilin	0.0687	0.1530	0.2177	0.2666	0.3596	0.3322	0.3513	0.4070	0.4228	0.4467	0.4754	0.4926
Heilongjiang Province	0.0787	0.1451	0.2292	0.2766	0.3653	0.3555	0.3715	0.4231	0.4406	0.4576	0.4881	0.5130
Shanghai	0.1434	0.2331	0.3235	0.4016	0.4947	0.4897	0.5191	0.6102	0.6571	0.6779	0.7298	0.8000
Jiangsu	0.1578	0.2274	0.3115	0.3490	0.4357	0.4198	0.4562	0.5343	0.5709	0.5958	0.6278	0.6975
Zhejiang	0.1453	0.2249	0.3167	0.3509	0.4422	0.4305	0.4597	0.5424	0.5842	0.5969	0.6355	0.6794
Anhui Province	0.1043	0.1757	0.2496	0.3120	0.3860	0.3887	0.4091	0.4757	0.5063	0.5206	0.5592	0.5872
Fujian	0.1246	0.1956	0.2838	0.3222	0.4045	0.3787	0.4056	0.4783	0.5087	0.5221	0.5553	0.5884
Jiangxi	0.0822	0.1577	0.2335	0.2943	0.3717	0.3637	0.3855	0.4460	0.4705	0.4887	0.5269	0.5447
Shandong	0.1114	0.1841	0.2711	0.3234	0.4169	0.4299	0.4676	0.5422	0.5513	0.5718	0.6208	0.6798
Henan	0.1067	0.1660	0.2462	0.2931	0.3792	0.3775	0.3997	0.4560	0.4798	0.4976	0.5303	0.5552
Hubei Province	0.1039	0.1759	0.2564	0.3045	0.3897	0.3861	0.4175	0.4752	0.5035	0.5181	0.5540	0.5831
Hunan	0.0987	0.1643	0.2430	0.2807	0.3704	0.3584	0.3841	0.4383	0.4637	0.4812	0.5173	0.5457
Guangdong	0.1854	0.2575	0.3643	0.4140	0.5117	0.5011	0.5569	0.6528	0.6963	0.6937	0.7523	0.8268
Guangxi	0.0994	0.1636	0.2312	0.2748	0.3625	0.3620	0.3727	0.4291	0.4512	0.4671	0.5038	0.5284
Hainan	0.1133	0.1811	0.2620	0.3065	0.4181	0.3793	0.3942	0.4444	0.4615	0.4692	0.4973	0.5204
Chongqing	0.0796	0.1485	0.2348	0.2874	0.3733	0.3704	0.3856	0.4466	0.4737	0.4921	0.5241	0.5830
Sichuan	0.0956	0.1728	0.2479	0.2837	0.3894	0.3822	0.4060	0.4592	0.5085	0.5212	0.5585	0.5712
Guizhou	0.0685	0.1469	0.2156	0.2831	0.3726	0.3700	0.3821	0.4349	0.4520	0.4636	0.4921	0.5111
Yunnan	0.0749	0.1543	0.2374	0.2845	0.3805	0.3703	0.3803	0.4333	0.4576	0.4736	0.5028	0.5215
Shaanxi	0.1098	0.1783	0.2489	0.3064	0.3897	0.3858	0.3992	0.4538	0.4788	0.4987	0.5320	0.5605
Gansu Province	0.0923	0.1657	0.2395	0.2944	0.3858	0.3447	0.3641	0.4136	0.4301	0.4477	0.4899	0.5056
Qinghai	0.0882	0.1789	0.2423	0.2813	0.3991	0.3674	0.3865	0.4302	0.4460	0.4590	0.5062	0.5247
Ningxia	0.0957	0.1618	0.2358	0.2867	0.4011	0.3457	0.3744	0.4200	0.4313	0.4475	0.4816	0.5079
Xinjiang	0.0771	0.1624	0.2488	0.2720	0.3688	0.3252	0.3560	0.4040	0.4244	0.4380	0.4735	0.4978
Mean	0.1056	0.1809	0.2610	0.3092	0.4016	0.3884	0.4111	0.4702	0.4965	0.5127	0.5490	0.5833

4.3. Benchmark Empirical

In this paper, Hausman test is used to determine the regression model. The original hypothesis is that all explanatory variables are exogenous, and the random effects regression model is adopted. The test result indicates that p=0.0000 is less than 0.01, that is, the original hypothesis is rejected and the fixed effects model is chosen. The regression results are shown in Table 6. Columns (1) to (6) are the results of using the fixed-effect model and controlling for both province and year. Column (1) indicates that the regression coefficient of industrial digitalization is significantly positive at the level of 1%, and the basis of gradually adding control variables shows that the regression coefficient of industrial digitalization is always significantly positive at the level of 1%, indicating that the development of industrial digitalization significantly promotes the improvement of export technology complexity, thus verifying the hypothesis of this paper. In addition, foreign direct investment (lnFDI) has a significant positive impact on the technical complexity of exports at the level of 1%, possibly because FDI brings advanced technology and management experience and promotes industrial upgrading and technological progress [35]. The financial level (FIN) has a significant negative impact at the 1% level, which may be due to the imperfect financial system and uneven distribution of financial resources, which fail to effectively support the export of products with high technical complexity [36]. In addition, regional development level (OPEN) and infrastructure (INST) both have a significant positive impact at the level of 1%. The former reflects that an open economic environment is conducive to technology introduction and innovation [37], while the latter indicates that good infrastructure is an important support for improving the technological complexity of exports [38]. In contrast, the level of industrial structure (IS) is not significant, which may mean that the current industrial structure has not yet had a significant direct effect on the improvement of export technological complexity [39].

Table 5. Study on the impact of industrial digitalization on export technology complexity

	(1) lnEXPY	(2) lnEXPY	(3) lnEXPY	(4) lnEXPY	(5) lnEXPY	(6) lnEXPY
lnIDT	0.2380***	0.2539***	0.2807***	0.2309***	0.2177***	0.2144***
	(2.6637)	(3.2313)	(3.8145)	(3.1230)	(2.8562)	(2.7280)
lnFDI		0.0417***	0.0383***	0.0362***	0.0337***	0.0314***
		(5.9847)	(5.6056)	(5.1812)	(4.8955)	(3.6605)
FIN			-0.0462***	-0.0452***	-0.0368***	-0.0414***
			(-3.5665)	(-3.5486)	(-2.8002)	(-2.9037)
OPEN				0.1500***	0.1070***	0.1210***
				(4.5968)	(3.0537)	(2.9704)
INST					0.3174***	0.3268***
					(3.9365)	(3.8613)
IS						0.0181
						(0.7463)
_cons	10.8093***	10.5096***	10.7216***	10.6416***	10.5037***	10.5017***
	(115.6891)	(131.0463)	(101.4620)	(99.3660)	(88.3466)	(87.5890)
N	360	360	360	360	360	360
adj. R^2	0.9573	0.9627	0.9648	0.9666	0.9681	0.9681
r2	0.9622	0.9671	0.9690	0.9707	0.9721	0.9722
Year	YES	YES	YES	YES	YES	YES
Province	YES	YES	YES	YES	YES	YES

Note: (1) Values in parentheses are T-values, (2) asterisks indicate significance levels: ** p< 0.05, *** p< 0.01.

5. Summary

This paper examines the impact of industrial digitalization on export technology complexity from both theoretical and empirical aspects. On this basis, this paper uses the balance panel data of Chinese provinces from 2011 to 2022 to measure the level of industrial digitalization in 30 Chinese provinces, and deeply discusses the impact of industrial digitalization on the complexity of export technology, aiming to reveal the role of industrial digital transformation in improving China's export competitiveness and quality. The results show that: First, in the process of research, we first found that the level of industrial digitization is closely related to the level of economic development. The economically developed eastern coastal areas, such as Beijing, Shanghai, Guangdong, Jiangsu and other places, have a high level of industrial digitalization, which provides strong support for the sustained growth of the local economy. In contrast, the level of digitalization in the central and western regions is relatively low, with certain regional differences. This unbalanced phenomenon not only reflects the current situation of China's economic development, but also reveals the importance of industrial digitization to economic development. Secondly, the development of industrial digitalization has a significant effect on the technical complexity of exports. Industrial digitalization can improve the technological complexity of export by improving regional innovation ability and opening level. Thirdly, this paper discusses the influence of industry digitalization on export technology complexity from the medium-term perspective of industry. Rather than short-term fluctuations and long-term trends, the medium-term perspective is more likely to reveal the actual role of digital transformation in industrial development.

Based on the above research results, we propose the following policy recommendations: (1) The government should fully recognize the importance of digital infrastructure construction for improving the overall digital level of the country, especially in the central and western regions, which are relatively backward in digital development due to historical, geographical and other reasons. Therefore, the government should increase investment in the construction of digital infrastructure in these regions, including expanding network coverage, building data centers and cloud computing platforms, so as to comprehensively improve the level of industrial digitalization in the central and western regions, gradually narrow the difference with the eastern region, and achieve a balanced and coordinated national digital development [38]. (2) The government should optimize the overall layout of industrial digitalization and promote the deep integration of the digital economy and the real economy. By setting up special funds and providing tax incentives, the government can support enterprises to carry out digital technology research and development and application, promote the deep integration of digital economy and real economy in the industrial chain and value chain, form a new pattern of mutual promotion and common development, and ultimately improve the overall technological complexity of China's export [40]. (3) The Government should strengthen intellectual property protection and international cooperation, provide a strong guarantee for scientific and technological innovation, and promote the international development of industrial digitalization. In terms of intellectual property protection, the government should establish and improve the relevant laws and regulations system, intensify the crackdown on infringement, and provide a good legal environment for enterprises' innovation activities. In terms of international cooperation, the government should actively participate in international digital economic cooperation and exchange, introduce foreign advanced digital technologies and experience, and promote the internationalization of China's industrial digitization [41]. At the same time, the government should also encourage enterprises to "go global", participate in international market competition, and enhance the status and influence of Chinese industries in the global value chain [42].

However, there are some limitations in this study. First of all, the data mainly comes from the balance panel data of China's provinces. Although the data is relatively comprehensive, there may be certain lag and limitations. Future research can further expand the data sources and introduce more real-time and detailed data to improve the accuracy and reliability of the research. Secondly, this study mainly discusses the impact of industrial digitalization on export technology complexity from a medium-term perspective. However, industry digitization is a long-term process, and its impact may involve multiple aspects and levels. Future research can further expand the research perspective, and further explore the overall impact of digital transformation on industrial development from a more macro and micro perspective.

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