

Digital Trade Network Status and Its Impact on Export Complexity

Jingying Li *

Department of Economics and Management, Nanjing University of Science & Technology, Nanjing, China

* Corresponding Author Email: lijingying@njust.edu.cn

Abstract. With the rapid development of information and communication technology, digital trade has become a key driving force for promoting economic growth, promoting enterprise transformation and improving the position of the global value chain. This paper selects the OECD service trade database digital trade agency data collection, using social network analysis, build the digital trade network between 22 countries in 2010-2021, and analyzes the development and evolution of digital trade network and the status of a country or a region in the digital trade network, the research results show that: observe the increasing digital trade between sample countries (regions), the number of economies trading partners, the breadth of digital trade between sample countries. From the perspective of the individual network characteristics of the economies, the fluctuation of the top countries or regions is small, while the fluctuation of the latter countries is large, indicating that the pattern of digital trade network has not been finalized, and there is still room for development. In addition, this paper also based on the panel data model empirical analysis of a country or regional digital trade network status on the influence of the export technology complexity, the study found that near the center of a countrys export technology complexity presents significant positive effect, shows that in the digital trade network, a countrys trade accessibility is higher, will have a positive impact on its export technology complexity.

Keywords: Digital trade; Trade network; Export technology complexity; Social network analysis method.

1. Introduction

The China Academy of Information and Communication, in the Global Digital Trade Rules Annual Observation Report (2022), indicated that due to the outbreak in 2020, global trade in services and trade in goods dropped by 20.0% and 5.6% respectively. In contrast, digital trade declined within 2.0%, with a trade scale as high as \$3.168 trillion, accounting for the proportion of total trade in services increasing from 47.3% in 2010 to 63.6%. It is evident that the current development potential of digital trade is extremely vast. Digital trade offers a new route for high-quality economic development and constitutes a "new track" to enhance the quality and efficiency of the global economy. It has become a consensus among all countries to vigorously develop digital trade and seize the commanding heights of digital trade. Therefore, assessing the law of the development and evolution of the global digital trade network and analyzing the relationship between the development of digital trade and digital trade governance have become the fundamental work to promote the catch-up of digital trade.

Traditional export trade indicators such as export quantity and value cannot fully evaluate a country or region's trade level and economic development. Instead, export technology complexity can more accurately reflect a country or region's trade export quality and commodity structure, and to a certain extent, mirror the international division of labor of the country or region [1]. Under the backdrop of an open economy, the connotation of international trade is expanding. For a country involved in the division of international trade, its status must lie in the trade relations with other countries within the network. Thus, social network analysis can reflect the relative status between countries (regions) and interconnected network characteristics [2]. The enhancement of the trade network status of digital trade can theoretically assist in improving the technological level of a country's digital economy development and help embed the traditional trade in goods into the global specialization.



So, how does the status of the digital trade network influence the complexity of digital trade export? The answer to this question is conducive to a systematic and comprehensive grasp of the development law of global digital trade, and subsequently provide useful reference for China to optimize the digital trade division network and profit distribution pattern, improve the strategic layout of the digital industry, and promote the high-quality development of the digital economy.

2. Literature review

In recent years, the academic research on digital trade mainly focuses on three aspects: the scope definition of digital trade, digital trade rules, and the effect of digital trade. So far, there is no single definition or concept of digital trade that is widely accepted by most scholars [3]. In 2017, the OECD explained the concept of digital trade from the perspective of the nature of the transaction, products, and participating partners. Based on the statistical perspective, the transaction can be defined as digital trade if it meets one of the three conditions: digital ordering, digital (platform) facilitation, and digital delivery. In September 2018, the China Institute of International Trade and Economic Cooperation (CAITEC) released the Global Services Trade Development Index Report (2018): Opportunities and Challenges for the Rise of Digital Trade at the Conference on Trade in Services. The report categorizes digital trade into three types: digital goods trade, digital service trade, and data trade. This definition originates from traditional trade and incorporates trade in goods, service trade, and data trade into the scope of digital trade, emphasizing the fundamental attributes of trade. Scholars both at home and abroad have also discussed the definition of digital trade. Ma Shuzhong et al. hold that digital trade is inseparable from traditional trade, and digital trade is derived from the extension of traditional trade through digital transformation [4]. Cross-border e-commerce constitutes the main component of digital trade, and digital trade in a more advanced form represents the future development direction of cross-border e-commerce [5]. The signing of RTA digital trade rules can steadily and significantly facilitate the rise of Chinese enterprises in the global value chain [6]. Regarding the utility that digital trade can bring, digital trade can promote the digitalization of commodity production, reduce information asymmetry, thereby reducing trade costs and enhancing trade efficiency and export performance [6,7,8,9]. Digital innovation and digital technology can effectively mitigate the impact of external economic uncertainty on global value chains and enhance the resilience of global value chains [10]. Some also have discovered that digital trade has transformed the composition of commodity trade [11,12]. Along with the development of the network platform, the number of cross-border small parcels is increasing, enabling the trade of low-value goods and services.

The literature on the complexity of export technology can be summarized as both index construction and influencing factors. Hausmann and Rodrik (2003) assert that each product has its own productivity level [13]. The greater the number of enterprises in industries engaged in higher productivity levels in the economy, the closer the overall productivity level is to the forefront of productivity, and the higher the level of economic development. Currently, the more classic and widely employed method for calculating the export complexity is the "cost discovery method" proposed by Hausmann et al. (2007), which combines cost uncertainty and consistency to measure the export complexity of different products and different countries. If a country or region can produce and export diversified and highly complex products, its economy is regarded as more complex and competitive [14]. From this perspective, Tacchella (2013) proposed the economic complexity index ECI measure to analyze the national or regional industrial structure and the relationships among products, labor cost, price market speculation, commodity pricing, economic inefficient currency bias [15]. Additionally, the export similarity index ESI can also be utilized to compare the degree of similarity between the two countries [16]. With the deepening of the division of the value chain, the factors influencing the complexity of export technology have attracted extensive attention from scholars. Gereffi (2016) maintains that the increased complexity of a country's export technology results from value capture in global value chains [17]. Other found through empirical research that

factors such as the degree of economic development, market size, economic openness, innovation and development investment, and human capital have an impact on the complexity of export [18,19].

Current research on digital trade networks emphasizes both network characteristics and network effects. Through the topological structure of the trade network, it is discovered that the global digital trade network and the global digital product network exhibit obvious "small world" features [20,21]. The competitiveness and complementarity among economies in global digital trade are escalating year by year, and the complementarity outweighs the competitiveness [22]. Regarding the effect of trade network status, through empirical research that China's global digital trade network has a significantly positive influence on China's import and export of digital services [23]; and a negative correlation with the degree of digital trade restrictions [24]. The digital trade rule network by utilizing the quantitative data of regional trade agreement (RTA) text, which empirically proves that the enhancement of the status of the network center of node countries can significantly promote the export of their digital services [25].

Most of the existing literature on the complexity of digital trade networks and export technology initiates from two parallel dimensions, and few literatures incorporate them within the same framework. In view of the fact that social network analysis can reflect the interdependence and interconnection among countries (regions), this paper adopts the social network analysis method to establish the global digital trade network, depicting the overall situation of the digital trade network and the relative status and network characteristics of countries within the digital trade network. On this basis, it empirically examines the role of a country's position in the digital trade network in enhancing the complexity of trade export technology, and puts forward policy suggestions for the strategic transformation of China's foreign trade

3. Digital trade network construction and descriptive analysis

3.1. The construction method of the global digital trade network

The digital trade network presented in this paper is a social network model that encapsulates the relationships between nodes. It takes the economies engaged in global digital trade import and export as the nodes, and the digital trade exports between these economies as the weights of the node connections. This network is defined as:

$$G=(V,E) \quad (1)$$

Where G represents the weighted global digital trade network. V represents all nodes, is a collection of all economies in the digital trade network, $V_i \in V$, $i=(1,2, \dots, n)$ represents the economies in the digital trade network. E represents all edges between nodes and the digital trade export relationship between nodes.

This paper adopts the processing method referenced from Zhao Wenxia (2022) and Zhou Nian and Chen Huan (2020), defining digital trade as "Potentially ICT-enabled Service Trade (PICTE)." [24,26] By comparing the statistical caliber of PICTE with the OECD bilateral service trade database, an industry identification method is employed for the statistical analysis of digital trade. The combined exports from six sectors—telecommunications, computer and information services, financial services, personal, cultural, and entertainment services, intellectual property fees, insurance and pension services, and other business services—are selected to represent the scale of digital trade for each economy each year.

In this study, digital trade data between countries (regions) for the 12-year period from 2010 to 2021, as recorded in the OECD bilateral service trade database, are selected. These data are then converted into matrix forms for countries and regions by year to construct a digital trade network. Due to the

availability and comparability of the data, this paper includes only 22 countries and regions from the OECD database, focusing on individual centrality measures within the network.

3.2. Digital trade network characteristics of the descriptive statistics

To more intuitively analyze the overall analysis of the global digital trade network, this paper uses Gephi software for visual analysis. Limited to space and data restrictions, this paper draws the digital trade network between the 22 countries in the world in 2010 and 2021, as shown in Figure 1 and Figure 2, by comparing the network diagram of the first and last two years of the sample period. Analyze the development and evolution of the digital trade networks between these 22 countries. In the figure, the solid dot represents the point degree of the trading country, that is, the number of trade contacts established by the trading country. The darker the dot is, the more the trade contacts of the trading country, the more trading partners. The connection represents the existence of trade between the two economies. As can be seen from the figure, the digital trade network pattern evolved dynamically between 2010 and 2021, and the trade links between countries became increasingly close, which is specifically reflected in the establishment of trade links between some countries.

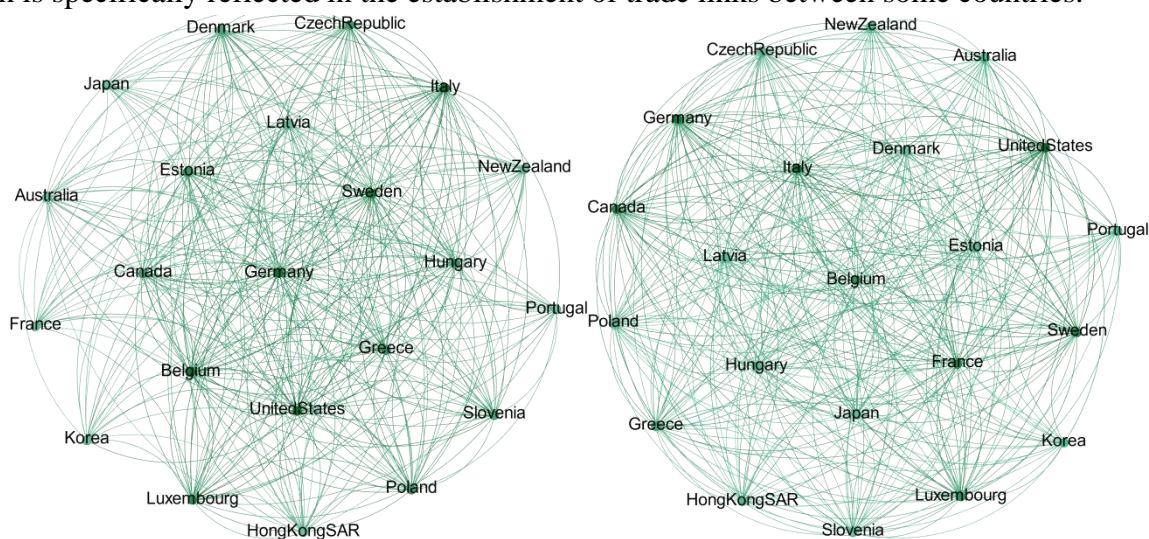


Fig. 1 Digital trade network structure diagram in 2010 and 2021

Starting from the integrity of the network, the density of digital trade network can reflect the degree of digital trade overall. This paper binary the data to get a more intuitive result, as shown in Table 1. In terms of trend, the network density increased in 2011 and fluctuated in 2013, with a rebound in 2014, and basically stabilized in the following years, finally rising to 0.834 in 2021.

Table 1. Density of digital trade networks from 2010 to 2021

| | | | | | | |
|---------|--------|--------|--------|--------|--------|--------|
| year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| density | 0.7549 | 0.8103 | 0.8103 | 0.7964 | 0.832 | 0.8221 |
| year | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| density | 0.8241 | 0.8221 | 0.8281 | 0.8142 | 0.8241 | 0.834 |

Degree centrality reflects whether a node is in the core position of the network, proximity to the center shows the reachability of nodes in the digital trade network, and intermediary centrality measures the ability of a node in the digital trade flow to influence the transactions of other nodes. While ranking all the countries according to these three indicators, it can be concluded that in the three indicators, the trading powers of the United States, Germany, France and Japan have always been in the forefront of the world, and the ranking behind has fluctuated greatly, but generally speaking, the developed countries in Europe occupy the core position.

3.3. PageRank Centrality degree

In addition to the degree of center, close to the center and intermediary the three basic individual network characteristics, this paper introduces the PageRank center to study the digital trade network status, the reason is that the PageRank center can more fully reflect the trade network characteristics, its strengthened trade links and weaken the influence of connected node center [27], because can reflect the trade network " the influence of proximity " and "central hub" two characteristics[28]. PageRank The calculation of the centrality degree needs to be continuously iterated through the correction rules, so that it finally converges to a stable value. The specific calculation formula sees the following equation:

$$PageRank(k)_{it} = \alpha \sum_{j=1}^N \bar{a}_{ji} \frac{PageRank(k-1)_{jt}}{outdegree_{jt}} + \frac{1-\alpha}{N} \quad (2)$$

In Equation (2), the PageRank centrality sets a scaling constant α that ranges between [0,1]. Following the referenced approach in this paper, α is set to 0.85. The outdegree of country j in year t is denoted as $outdegree_{jt}$, \bar{a}_{ji} represents the elements in the trade matrix, and N is the number of nodes in the trade network. The PageRank centrality of each economy is calculated using Python. The PageRank centrality reflects the status of a country or region within the digital trade network, the higher the value, the more central the position of the country in the digital trade network.

4. Empirical study on the influence of digital trade network status on the complexity of export technology

4.1. Model building

To further examine the relationship between the status of the digital trade network and the export complexity of a country or region, this paper uses Ma Shuzhong et al. (2016) to establish the following regression model [29]:

$$\ln Extech_{it} = \alpha PageRank_{it} + i \sum_j \beta_j X_{ijt} + \lambda_i + \gamma_t + \varepsilon_{it} \quad (3)$$

In the model, the subscript i represents a country or region, and t represents the year. $\ln Extech_{it}$ is the dependent variable of the model, indicating the logarithm of the digital trade export technological complexity for each country or region. $PageRank_{it}$ is the PageRank centrality of the digital trade network, which is the main independent variable of the model. X_{ijt} represents a series of control variables, including a country's economic development, market demand, openness, foreign capital inflow, and physical capital. λ_i denotes the country fixed effects, which are time-invariant factors that influence a country's position in the digital trade network. γ_t represents the time fixed effects, which are country-invariant factors that influence a country's position in the digital trade network. ε_{it} is the stochastic disturbance term that follows a standard distribution.

4.2. Variable selection

4.2.1. Explained variable

The explained variable $\ln Extech_{it}$ is the log value of the technical complexity of the digital trade export in each country or region. For the calculation of export technology complexity index, this paper refers to Hausmann et al. (2007) and constructs in the following way: Firstly, the export technological complexity Tsi_k of each type of digital trade mode k for countries or regions in year t is calculated, which is derived from the weighted average of the per capita GDP of each country or region under that trade mode. Secondly, based on the detailed measurement of the export

technological complexity of each trade sub-item, the export technological complexity $Extech_i$ of a country or region is estimated [14].

$$Tsi_k = \sum_i \frac{\left(\frac{x_{ik}}{x_{jk}}\right)}{\sum_j \left(\frac{x_{jk}}{x_{jk}}\right)} Y_i \quad (4)$$

$$Extech_i = \sum_k \frac{x_{ik}}{x_{ik}} \times Tsi_k \quad (5)$$

In the formula, i denotes the exporting country (region), j denotes the importing country (region), and k represents the type of digital trade. Y_i indicates the per capita GDP of country i ; $\frac{x_{ik}}{x_{jk}}$ represents the share of country i 's export of digital trade type k ; $\sum_j \left(\frac{x_{jk}}{x_{jk}}\right)$ denotes the sum of the shares of exports of digital trade type k for all sample countries. The higher the export technological complexity of a country or region, the stronger its export competitiveness. Data source: OECD bilateral service trade database.

4.2.2. Explanatory variable

The core explanatory variable of this paper is the PageRank centrality of a country or region, and the specific construction of this index is elaborated in Section 3.

4.2.3. Controlled variable

After reading the literature related to the complexity of export technology, this paper mainly selected the following control variables based on previous studies. The description of the specific variables is shown in Table Table 2.

Table 2. Description of the control variables

| variable | meaning | measure | data sources |
|-----------|----------------------------|--|--|
| rgdp | per capita GDP | Current price in one thousand dollars | WDI data base |
| fdi | Foreign direct investment | Foreign direct investment in one thousand US dollars | WDI data base |
| RD | R&D investment intensity | Share of R & D investment in GDP | WDI data base |
| schooling | Average years of education | (Years of education * proportion of population) / total population | Education Scientific and Cultural Organization |
| Open | Openness of trade | The proportion of imports and exports of goods and services in GDP | WDI data base |

4.3. Benchmark model regression

4.3.1. Descriptive statistics

Before conducting the regression analysis, this paper provides descriptive statistics for the main variables, with Table 3 presenting the results of the descriptive statistics. It can be observed that the mean value of $lnExtech_{it}$ is 8.56, indicating that the level of export technological complexity of the sample countries is relatively high. The main explanatory variable, after taking the logarithm, $lnPageRank_{it}$, has a mean value of 3.4 and a variance of 0.875, which effectively mitigates the impact of heteroskedasticity.

Table 3. Descriptive statistics of the variables

| VarName | Obs | Mean | SD | Min | Median | Max |
|-------------|-----|-------|-------|--------|--------|--------|
| lnExtech | 264 | 8.56 | 3.313 | 2.164 | 8.733 | 15.282 |
| ln pagerank | 264 | 3.40 | 0.875 | 2.043 | 3.423 | 5.603 |
| lnrgdp | 264 | 10.44 | 0.543 | 9.343 | 10.566 | 11.802 |
| lnfdi | 239 | 23.24 | 1.785 | 17.328 | 23.311 | 26.960 |
| Open | 264 | 1.17 | 0.906 | .234 | .866 | 4.426 |
| RD | 264 | 2.00 | 0.951 | .435 | 1.789 | 5 |
| schooling | 264 | 12.27 | 1.150 | 8.058 | 12.477 | 14.132 |

4.3.2. Analysis of the benchmark regression results

This paper uses the digital trade data of 22 countries or regions from 2010 to 2021 to empirically analyze the impact of digital trade network on the complexity of export technology. The first column of Table 4 reports the results of the benchmark regression. As can be seen from the regression results, the influence of PageRank centrality on the export complexity index is significantly positive, which means that for every 1 percentage point increase in the PageRank centrality of a country, the export technology complexity of a country increases by 0.035 percentage points.

The coefficient of GDP (lnrgdp) per capita is positive and significant, which is consistent with the general research conclusions. The increase of per capita GDP can drive the improvement of the overall competitiveness of the national economy. The increase of per capita GDP may lead to the transformation of industrial structure from low value-added and low-technology industries to high value-added and high-tech industries. This will encourage the country to conduct more high-tech production and export and improve the technical complexity of export products.

The coefficient of trade openness (Open) is significantly positive, indicating that improving trade openness is conducive to improving the complexity of export technology of a country or region. On the one hand, improving trade openness is beneficial to reducing trade resistance with other countries, reducing trade costs and expanding trade scale; on the other hand, the higher the trade openness, the more advanced technology and first-class management experience from a large number of international trades, so as to improve their competitiveness.

The coefficient of foreign direct investment (lnfdi) is negative, but this is not significant. This is mainly due to the complex impact of FDI on the export technology complexity, which has both positive and negative effects on the host country. On the one hand, the entry and increase of foreign investment will encourage the host enterprises to absorb more advanced technology, thus improving the technology level and having a positive impact on the export technology complexity; on the other hand, the foreign exporting countries tend to invest the marginal industries with low technology level such as some manufacturing industry in the host country, and internalize the core technology, thus inhibiting the export technology complexity of the host country.

The coefficient of R & D investment (RD) was negative, but it did not pass the significance test. This is because the increase in R & D investment has both incentive and crowding out effects [30]. On the one hand, the transformation of R&D investment into innovation ability has a certain time lag, and it may not be completely converted. Only when a country's R&D investment is matched with economic development, labor quality, infrastructure and other factors, can the complexity of export technology be effectively promoted. On the other hand, the immediate promotion of innovation through R&D investment increases the technology level, and will not necessarily export it, but lock the core technology to maintain its international competitiveness [31]. Therefore, the R&D investment level of a country cannot be fully reflected in the complexity of export technology.

Table 4. Results of benchmark models

| | (1) | (2) | (3) | (4) | (5) |
|----------------------------|------------|------------|------------|------------|------------|
| Inpagerank | 0.035** | | | | |
| | (0.016) | | | | |
| Degree | | 0.037 | | | 0.038 |
| | | (0.019) | | | (0.021) |
| Closeness | | | 0.449*** | | 0.441*** |
| | | | (0.115) | | (0.117) |
| Betweenness | | | | -0.001 | 0.022 |
| | | | | (0.014) | (0.015) |
| lnrgdp | 1.984*** | 2.009*** | 2.039*** | 1.981*** | 2.110*** |
| | (0.198) | (0.197) | (0.192) | (0.200) | (0.195) |
| lnfdi | -0.019 | -0.017 | -0.004 | -0.018 | -0.008 |
| | (0.023) | (0.023) | (0.022) | (0.023) | (0.022) |
| RD | -0.095 | -0.103 | -0.071 | -0.098 | -0.073 |
| | (0.096) | (0.095) | (0.093) | (0.096) | (0.093) |
| schooling | -0.104 | -0.101 | 0.058 | -0.105 | 0.040 |
| | (0.071) | (0.070) | (0.080) | (0.072) | (0.080) |
| Open | 0.092* | 0.079* | 0.012 | 0.098** | 0.007* |
| | (0.188) | (0.186) | (0.183) | (0.188) | (0.182) |
| _cons | -10.225*** | -10.398*** | -12.868*** | -10.109*** | -13.290*** |
| | (2.104) | (2.068) | (2.129) | (2.084) | (2.139) |
| <i>N</i> | 239 | 239 | 239 | 239 | 239 |
| Time fixed effect | √ | √ | √ | √ | √ |
| Individual fixation effect | √ | √ | √ | √ | √ |

4.4. Robustness test

4.4.1. Replace explanatory variables

This paper uses PageRank center as an index to measure the status of trade network, but there are many other methods to measure trade network characteristics, in order to more fully reflect the breadth and depth of countries participation in trade network, this paper selected the commonly used trade network characteristics, namely, close to the center and intermediary center, the regression results as shown in table 5 column (2) ~ (5). The values of the three centrdegrees were calculated by the Ucinet software. Degree, Closeness, Betweenness corresponding center, close to the center and mediation center, can be found besides close to the center, degree center and mediation center coefficient is not too significant, suggesting that in this paper based on the OECD database construction of digital trade network, the greater the accessibility between trading countries, will have a positive impact on its export technology complexity.

4.4.2. Endogenous treatment

To alleviate the problem of possible causal endogeneity, this paper uses the PageRank centrality and Degree, Closeness, and Betweenness for regression. The results of the lag phase regression are basically consistent with the benchmark regression.

5. Conclusion

As a combination of Internet technology and traditional trade, digital trade has greatly reduced the cost of trade, and has produced a positive effect on trade globalization to a certain extent. In order to explore the status of global digital trade network and its influence on the export technology complexity of a country, this paper refers to the Zhou and Chen Huanqi (2020), select the database of economic cooperation and development, and use social network analysis to build the digital trade network between 22 countries in the world in 2010-2021, analyzes the development and evolution of digital trade network and the status of a country or region in the digital trade network. In addition, this paper also empirically analyzes the impact of the digital trade network status of a country or region on its export technology complexity based on the panel data model. The main conclusions are as follows:

First, through the construction of digital trade network, from the network visualization, the overall network characteristics and the perspective of digital trade network analysis found: (1) between 2010 and 2021 samples between countries (regions) increasing digital trade, growing economies of trading partners, expand the breadth of digital trade. (2) The density of the overall network between the sample countries fluctuated between 2010 and 2021, indicating that the digital trade links between the sample countries became increasingly close. (3) From the perspective of the ranking of individual network characteristics of the digital trade network, the top countries fluctuate small, the trading powers the United States, Germany, France, Japan are in the core position of the digital trade network during the sample observation period; the latter period, Hong Kong, China, Sweden, Poland and other economies began to rise, indicating that the digital trade network pattern has not been finalized and there is still room for development.

Second, by constructing the panel data model empirical analysis found: (1) characterize the topological characteristics of a country's digital trade network status of PageRank center of the role of a country's export technology complexity presents significant positive effect, and replace the core explanatory variables, close to the center of a country's export technology complexity also presents significant positive effect, shows that in the digital trade network, a country's trade accessibility, will have a positive impact on its export technology complexity.

Based on the above conclusions, this paper intends to put forward the following countermeasures and suggestions to provide some basis for promoting China's active integration into the global digital trade network and enhance the complexity of export technology and enhance export competitiveness.

First, actively participate in and integrate into the global digital trade network. On the one hand, the pressure on domestic resources and environment is increasing, the cost advantage of factors is gradually weakening, and the traditional comparative advantage of China's foreign trade is fading. It is particularly important to expand the application of digital trade and seize the right power of digital trade. On the other hand, we should properly handle the trade relations with the economies at the core of the global digital trade, stabilize cooperation, and actively expand the trade network with the marginal economies with the help of the "Belt and Road" new Silk Road, to build a large and dense digital trade network with China as the core.

Second, we will improve the digital infrastructure, represented by the Internet. As the "new productivity" mode of the digital industry, the improvement and allocation of new infrastructure such as the Internet, 5G and the Internet of Things is an important basis for ensuring the development of digital trade and can also further promote the facilitation of digital trade.

Third, China's foreign trade development has entered the new normal stage, so the government should improve the transparency of technical trade measures and the level of trade liberalization, to strengthen the advantages of China's trade network status. According to the utility of individual networks, the higher the trade accessibility of a country, it will have a positive impact on the complexity of its export technology. Firmly seizing the opportunity of the development of digital economy, introducing the liberalization clause of trade in digital products and services will provide a freer environment for data flow, which will help to further enhance the complexity of China's export technology.

References

- [1] Lall S, Weiss J, Zhang J. The “Sophistication” of Exports: A New Trade Measure [J]. *World Development*, 2006, 34(2): 222-237.
- [2] Serrano MA, Boguñá M. Topology of the World Trade Web[J]. *Physical Review E*, 2003, 68(2): 1-5.
- [3] Zhang Zhengrong, Yang Jindong, GU Guoda. Dimension of the concept of digital trade, international rules and business model [J]. *Journal of economists*, 2021, No. 268 (4): 61-69. The DOI: 10.16158 / j.carol carroll nki. 51-1312 / f 2021.04.008.
- [4] Ma Shuzhong, Fang Chao, Liang Yinfeng. Digital trade and its times value and research prospects [J]. *International Trade Issues*, 2018(10):16-30. (In Chinese)
- [5] Zhang Xiaoheng. Symbiosis or iteration: Rethinking cross-border e-commerce and global digital trade [J]. *Contemporary Economic Management*, 2019,42(11):43-50.
- [6] Hou Junjun, Wang Yindan, Wang Zhenguo. Digital global trade rules and China's enterprise value chain position [J]. *China industrial economy*, 2023, No. 421 (04): 60-78. The DOI: 10.19581 / j.carol carroll nki ciejournal. 2023.04.012.
- [7] Fan Xin. Digital economy development, international trade efficiency and trade uncertainty [J]. *Finance and economy*, 2020, 9 (8): 145-160. The DOI: 10.19795 / j.carol carroll nki cn11-1166 / f 2020.08.010.
- [8] Zhang Hongsheng, Pan Gangjian. Cross-border e-commerce and bilateral trade costs: An empirical study based on cross-border e-commerce policies [J]. *Journal of Economic Research*, 2019,56(09):141-157.
- [9] Subirana B. Zero entry barriers in a computationally complex world: Transaction streams and the complexity of the digital trade of intangible goods[J]. *Journal of Organizational and End User Computing (JOEUC)*, 2000, 12(2): 43-55.
- [10] Dilyard J, Zhao SS, You JJ. Digital Innovation and Industry 4.0 for Global Value Chain Resilience: Lessons Learned and Ways Forward[J]. *Thunderbird International Business Review*, 2021, 7: 1-22.
- [11] Meltzer JP. Maximizing the opportunities of the internet for international trade[C]. In: *ICTSD and World Economic Forum*, 2016.
- [12] González JL, Jouanjean MA. Digital trade: developing a framework for analysis[J]. 2017.
- [13] Hausmann R.,Rodrik D.2003,Economic Development as Self-Discovery [J].*Journal of Development Economics*,72(2),603~633.
- [14] Hausmann R, Hwang J, Rodrik D. What you export matters[J]. *Journal of Economic Growth*, 2007, 12(1): 1-25.
- [15] Tacchella A, Cristelli M, Caldarelli G, et al. Economic complexity: conceptual grounding of a new metrics for global competitiveness[J]. *Journal of Economic Dynamics and Control*, 2013, 37(8): 1683-1691.
- [16] Schott P K. The relative sophistication of Chinese exports[J]. *Economic policy*, 2008, 23(53): 6-49.
- [17] Gereffi G. Global Value Chains and Upgrading: Export Promotion in FTZs [Free Trade Zones] [J]. *Social Science Electronic Publishing*, 2016.
- [18] Zhao Hong, Peng Xin. Research on the complexity of China's export technology and its influencing factors [J]. *China Soft Science*, 2014(11):183-192. (In Chinese)
- [19] Zhang Yu, Dai Xiang. What influences the complexity of service exports: An empirical study based on 112 global economies [J]. *International trade issues*, 2015 (7): 87-96. The DOI: 10.13510 / j.carol carroll nki. Jit. 2015.07.009.
- [20] Wang Yan-Fang, CAI Min, Dai Yue. Digital trade network topology structure, evolution logic and influencing factors of [J]. *Journal of financial research*, 2022, No. 466 (9): 56-65. The DOI: 10.19654 / j.carol carroll nki cjwtyj. 2022.09.006.
- [21] Zhao Wenxia, Xi Yanling, Yang Jingguo. Digital products trade network structure characteristics and the cooperation situation study [J]. *Science and technology of China BBS*, 2023 (02): 146-158. The DOI: 10.13580 / j.carol carroll nki FSTC. 2023.02.023.

- [22] Liu Min, Xue Weixian, Zhao Jing. Competitive complementarity and its evolution in global digital trade: Based on social network analysis [J]. *Exploration of international economy and trade*, 2021, 5 (10): 54-69. The DOI: 10.13687 / j.carol carroll nki GJJMTS. 2021.10.004.
- [23] Wen Huwei, Shu Shizhe, Zheng Shufang. The global digital pattern of trade in services and China's trade status analysis [J]. *Industrial economic review*, 2021 (01): 50-64. The DOI: 10.19313 / j.carol carroll nki cn10-1223 / f 2021.01.005.
- [24] Zhao Wenxia. The global digital trade network structure and its relationship with digital trade restrictions [J]. *China's circulation economy*, 2022, 4 (1): 14-25. DOI: 10.14089 / j.carol carroll nki cn11-3664 / f 2022.10.002.
- [25] Shi Benye, Qi Ruiqing. Digital to digital services export trade rules network [J]. *The influence of world economic studies*, 2023 (3): 16 + 3-134 DOI: 10.13516 / j.carol carroll nki. Wes. 2023.03.007.
- [26] Zhou Nianli, Chen Huanqi. RTAs within the framework of American digital trade rules of the trade effect research [J]. *Journal of world economy, the lancet*, 2020 (10): 28-51. DOI: 10.19985 / j.carol carroll nki cassjwe. 2020.10.003.
- [27] Hong Junjie, Shang Hui. Research on the decision mechanism of hub status in international trade network [J]. *Issues of International Trade*, 2019, (10): 1-16
- [28] Lv Yanfang, Fang Ruonan, Wang Dong. Global digital service trade network topological structure characteristics and the influence mechanism of [J]. *Journal of quantitative technical economics*, 2021, 38 (10): 128-147. The DOI: 10.13653 / j.carol carroll nki jqte. 2021.10.007.
- [29] Ma Shuzhong, Ren Wanwan, Wu Guojie. The characteristics of a country's agricultural trade network and its impact on the division of labor in global value chains: from the perspective of social network analysis [J]. *Management World*, 2016(03):60-72.
- [30] [30] Li Ping, Jiang Li. Trade liberalization, intermediate imports and technological innovation in China: An empirical study of provincial panel data from 1998 to 2012 [J]. *International trade issues*, 2015 (7): 11 + 3-96 DOI: 10.13510 / j.carol carroll nki. Jit. 2015.07.001.
- [31] Shao Hanhua, Li Ying, Wang Yuansheng. Trade network status and export technical complexity: An empirical analysis based on transnational panel data [J]. *Journal of Guizhou University of Finance and Economics*, 2019(03):1-11.