

A Study of the Global Trade Network of the Electronic Information Industry from a Value Added Perspective

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ABSTRACT

Under the background of globalization, the connotation of trade network is expanding. Under the traditional method, the trade network constructed using trade volume cannot better reflect the actual profitability of international trade in electronic information industry, and ignores the impact of trade value added on the trade network. Therefore, from the perspective of value added, this paper adopts the complex network analysis method to study the overall characteristics, main node characteristics, and main cluster characteristics of the global electronic information industry value added trade network. The results show that China, the United States, Germany, India, the United Kingdom import and export value-added trade volume is in the forefront, and plays an important "bridge" role, is the most important economy in the trade network. The value-added trade network mainly consists of two clusters, namely the cluster of developed countries and emerging market economies represented by China, the United States, Japan, South Korea and other economies, and the cluster of relatively developed economies represented by Germany, Ireland, the United Kingdom and France.

KEYWORDS

global electronic information industry; trade networks; trade in value added; market research and information

1 Introduction

In the process of opening up the global economy, both developed and developing countries are actively promoting informatization as a key strategy to facilitate profound industrial change and structural restructuring and to enhance their comprehensive national power. The electronic information industry is an important pillar of the modern economy, covering a wide range of fields such as communications, computers, semiconductors and consumer electronics. As one of the most influential industries in the information age, electronic information industry not only occupies an important position in international trade, but also has become the main battlefield of international competition. In the face of rapidly changing international trade market, in-depth study of the global electronic information industry trade network has important practical significance.

Duncan J. Watts and Steven Strogatz et al. for the first time the complex network analysis method is applied to the study of trade network, B. A. Huberman and L. A. Adamic et al. in the study in 1999, explored the topology of the global trade network. explored the topology of global trade networks ^[1], which provided a theoretical basis for later researchers to apply complex network analysis to trade networks. Subsequent researchers have carried out refined studies on trade networks in specific areas, such as: global trade networks for high-tech products ^[2], trade networks for agricultural products ^[3] and so on. In recent years, some researchers have devoted themselves to exploring the impact of trade policy on the structure of trade networks and global value chains, among which Zhang Tianding et al. have pointed out that RTAs and global value chains are interconnected, interdependent, and co-evolving ^[4]. Some researchers have also noted the rise of new trade forms such as digital trade and e-commerce and pondered the impact of these factors on trade networks, in which Yang Bizhou and Peng Yu analyzed the structural characteristics of the global FTA digital trade rules network and followed up with empirical analysis ^[5].

This shows that the research on trade networks has been developed to more refined specific areas, and researchers will take more into account the impact of digital trade, e-commerce, related policies and other new factors on trade networks. The development of trade network research methodology and technology provides a more solid theoretical foundation for further research on the trade network of value-added of electronic information industry. As an important part of global trade, the trade network of electronic information industry trade has been relatively mature.

In 2017, Gao Spinoyang and Li Junwei studied the evolutionary characteristics of the global electronic information industry trade network, and came to the conclusion that the overall expansion of the global trade network of electronic information industry ^[6]. In recent years, a part of researchers analyzed the competition and innovation methods in the electronic information manufacturing industry. While researchers study the overall and various aspects of the characteristics of the global electronic information industry, they also pay attention to the evolutionary trend of the international trade network of the electronic information industry. Some new factors such as: value chain, and the impact of digital trade on the global e-information industry trade are also being considered. The development of the digital economy has led to changes and transformations in EITI trade, as well as the prominence of trade policy, sustainable

development and other influencing factors, implying that the study of EITI in the global trade network is yet to be further deepened. In the context of digital economy and global economic openness, this study is important for grasping the trend of industrial change and enhancing China's position in the global value chain.

2 Data collection and modeling

The value-added trade data of electronic information industry comes from the value-added trade dataset in the OECD's International Trade and Balance of Payments Database, which contains the value-added trade data of 95 economies and 70 industries in the period of 1995–2020. Since the research of this paper addresses the international trade situation of the electronic information industry, the electronic information industry is selected among 70 industries. After considering the availability of data and the degree of newness, this paper selects the value-added trade data of the electronic information industry of 76 major international trade participants in 2019 to construct the trade network.

From the perspective of topology, the global EDI value-added trade network is not only a simple collection of multiple economies, but also includes different characteristics of economies and intricate EDI value-added trade relations between economies. Based on the method of complex network analysis, this paper uses nodes to represent an economy and edges to represent the trade relationship of value-added of electronic information industry between two economies, constructs a weighted directed trade network, and uses the trade amount of value-added of electronic information industry between two economies as the weight of edges, and the constructed network can be represented by a ternary group:

$$\alpha = (\beta, \gamma) \quad (2.1)$$

where $\beta = \{\beta_1, \beta_2, \dots, \beta_n\}$ denotes the set of nodes, where the element β_i denotes the 76 economies selected in this paper that participate in the global value-added trade of the ESI. $\gamma = \{\delta_{ij}, \varepsilon_{ij}\}$ denotes the set of edges, where the element δ_{ij} denotes the import-export trade relationship between economy i and economy j . Therefore, each edge δ_{ij} in the set of γ corresponds to a pair of economy nodes (β_i, β_j) in β . ε_{ij} denotes the trade volume of import and export value added between economy i and economy j , which is the weight of the edge. For the element ε_{ij} , if there is no trade between economy i and economy j , then ε_{ij} is zero, otherwise, ε_{ij} is assigned as the trade volume of value-added exports and imports of EI between economy i and economy j . The weight of an edge is the trade volume of value-added exports and imports of EI between economy i and economy j .

3 Characterization of global value-added trade networks in the electronic information industry

3.1 Overall Characterization of the Network

First of all, we briefly analyze the global value added trade network of the electronic information industry in 2019, as shown in Table 3.1, there are 76 nodes and 5,362 connecting edges in the network, and the density of the network is 0.941, which indicates that the trade network is almost close to a connected graph, and almost all the world's major economies participate in the international value added trade of the electronic information industry in 2019. The average path length of the network is 1.059, which is very close to 1, indicating that almost every two economies have a direct trade relationship.

In addition, Clustering Coefficient of the network is 0.95, indicating that the economies participating in the world trade in value added of ESI are interacting with each other, interconnected and inseparable.

Table 3.1 Overall Characteristics of the Global Electronic Information Industry Value Added Trade Network, 2019

network indicator	measurement
Number of Network Nodes	76
Number of Network Edges	5362
Network Density	0.941
Average Path Length	1.059
Clustering Coefficient	0.95

3.2 Main Node Analysis

The analysis of node characteristic indexes is to explore the status and role of specific nodes in the network. In this paper, the weighted in-degree, weighted out-degree, mediated centrality and proximity centrality indices are chosen to reflect the characteristics of the nodes in the global EITI value added trade network in 2019.

The calculation of these indices provides a more accurate understanding of the characteristics of specific individuals. Table 3.2 gives the results of measuring the characteristics of the nodes of the global value-added trade network of the electronic information industry in 2019, ranked in ascending order by the size of the value of each index, and listing the

top 10 economies respectively.

Table 3.2 Top 9 economies in terms of network node characterization indicators

rankings	weighted entry		weighted outcome		Intermediation Center Degree		proximity to center	
1	China	263842	China	402303	China	0.96	China	0.98
2	United States	215254	United States	206863	United States	0.89	United States	0.94
3	Germany	111520	South Korea	114024	Germany	0.81	Germany	0.88
4	Japan	109080	India	101174	India	0.79	India	0.87
5	South Korea	60095	Germany	85883	United Kingdom	0.74	United Kingdom	0.83
6	Ireland	58188	Japan	81995	Ireland	0.72	Ireland	0.81
7	France	57122	Singapore	61888	Switzerland	0.71	Switzerland	0.80
8	Mexico	52202	Ireland	60082	France	0.70	France	0.79
9	United Kingdom	49523	United Kingdom	50594	Japan	0.69	Japan	0.78

To summarize, China, the United States, Germany, India and the United Kingdom occupy a central position and play an important role in the global value-added trade network of the electronic information industry, and they can promote the development of international value-added trade in the electronic information industry and influence the pattern of international value-added trade in the electronic information industry. These economies control most of the global electronic information industry value-added trade market, and adjust in the continuous development of the market, forming a more coordinated division of labor. In the global electronic information industry value-added trade in 2019, China is in the first place in the world in all indicators, which shows that China plays a pivotal role in the international electronic information industry value-added trade, including sales, purchases, communication, cooperation, etc., and plays a huge role in the process of building a "community of human destiny". It plays a great role in the process of building a "community of human destiny".

3.3 Analysis of major clusters

Table 3.3 Global Value Added Trade Network Cluster Analysis for the Electronics and Information Industry, 2019 (Threshold: 71 Million USD)

Cluster number	economies
1	China, United States, Japan, South Korea, India, Singapore, Mexico, Malaysia, Canada, Thailand, Philippines, Australia, Vietnam, Brazil, China-Hong Kong, Indonesia, Saudi Arabia, South Africa, Argentina, New Zealand, Colombia, Nigeria, Chile, Egypt, Peru, Pakistan, Bangladesh, Costa Rica, Côte d'Ivoire, Cambodia, Jordan. Iceland, Myanmar, Laos, Senegal
2	Cameroon
3	Brunei
4	Germany, Ireland, United Kingdom, France, Switzerland, Netherlands, Spain, Italy, Sweden, Russia, Israel, Poland, Belgium, Austria, Czech Republic, Finland, Luxembourg, Hungary, Denmark, Romania, Turkey, Norway, Ukraine, Portugal, Slovakia, Cyprus, Morocco, Greece, Belarus, Kazakhstan, Estonia, Malta, Bulgaria. Tunisia, Slovenia, Croatia, Lithuania, Latvia.

Based on the aforementioned cluster division methodology, this paper divides the global EITI value added trade network in 2019. As can be seen from Table 3.3, Cluster 1 contains a number of developed and emerging market economies. In Cluster 1, on the one hand, some economies (e.g., China, the United States) have an important geopolitical position, which will have an impact on the trade of the neighboring economies in terms of the value-added of the electronic information industry. On the other hand, some economies have large populations (e.g., India, China, the United States, Indonesia, Pakistan, Brazil) or are rich in natural resources (e.g., Saudi Arabia, Canada, Australia, Brazil, Indonesia, South Africa). Economies in this cluster usually have some competitive advantage in EDI trade, which provides a solid foundation for foreign trade, and thus these economies are usually active players in international EDI trade and actively establish trade links with other economies. Cluster 4 contains some relatively developed economies with high industrialization and technological level, political and social stability, and high quality of life of the people, so they form stable trade relations with each other in the value-added trade of the electronic information industry, and occupy a certain share in the global value-added trade network of the electronic information industry with a greater influence. China and the United States, Japan, South Korea, India and other economies belong to the same module, has a closer trade relations, the main economies to provide exports to China is Japan, South Korea, while China mainly to the United States, Japan, South Korea, Mexico to provide exports.

4 Conclusion

This paper provides an in-depth analysis of the global value-added trade network of the electronic information industry. It is found that the network has wide participation and close trade links globally, but a few economies occupy

major market shares, showing the characteristics of complexity and closeness as well as great development potential. In terms of major nodes, China, the United States, Germany, India and the United Kingdom are at the core, with China ranking first globally in all indicators and demonstrating strong influence through active diplomatic and trade relations. Cluster analysis shows that in 2019, the global value-added trade network of the electronic information industry mainly forms two clusters: one is centered on the economies of China, the United States, Japan, South Korea, and India, with geopolitical, demographic, and resource advantages; and the other is dominated by the developed economies of Germany, the United Kingdom, and France, which are characterized by high levels of industrialization and technology. China has close trade relations with economies such as Japan, South Korea and exports mainly to the United States, Japan, South Korea and Mexico. Overall, the global value-added trade network of the electronic information industry shows a multipolar and clustered development trend, with China occupying a central position and playing an important role in the global network.

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