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Research on the Structural Characteristics and Evolution of the Asia-Pacific Trade Network of the ICT Industry

—From the Perspective of Global Value Chain

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Abstract

The ICT industry has gradually become an important industry in the regional economy. The global traditional, simple and complex value chain trade network has undergone fundamental changes during the evolution process, which has changed the overall pattern of the global value chain trade network. This article uses the UIBE GVC Indicators database, based on the global value chain theory to construct a trade network for the ICT industry in the Asia-Pacific region by the means of social network analysis methods. It uses the visualization software Gephi to analyze the evolution characteristics of the Asia-Pacific trade network in the ICT industry from 2005 to 2015. The analysis results found that: the total volume of the trade network continued to improve steadily, the location of the regional center of the trade network has changed. The steady network has helped the recovery of the trade after the external shocks. Also, China has played a more significant role in the ICT industry's network from the perspective of global value chain.

Keywords

ICT Industry, Trade Network Evolution Characteristics, Global Value Chain

1. Introduction

The ICT industry is a new technology field formed by the integration of the information technology (IT) and communication technology (CT) industries, with branches in the manufacturing and service industries. The ICT industry is a

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strategic industry that builds a national information infrastructure and supports economic and social development. Countries around the world focus on strengthening support for the development of the ICT industry. During the "12th Five-Year Plan" period, China listed the ICT industry as one of the seven strategic new industries, which promoted the rapid development of the ICT industry. Especially after entering the "14th Five-Year Plan", China's ICT industry has transformed from large-scale development to high-quality development and plays an important role in Asia and the world.

With the development of global value chains, the degree of regionalization of trade has increased day by day, and important changes have taken place in the characteristics and structure of the international division of labor in ICT. The rapid rise of China's ICT industry has greatly changed the overall pattern of the industry's global value chain trade network, especially in the Asia-Pacific region. From the perspective of the global production network topology, China has gradually become an important supply and demand center in traditional trade and global value chain production, while the United States and Germany are still the most important hubs in the complex global value chain network.

This article uses social network analysis methods, based on the global value chain theory and international division of labor theory, and the value-added data of the UIBE GVC Indicator database from 2005 to 2015, to construct an ICT industry trade network in the Asia-Pacific region, and analyzes the changes in the total import and export volume of traditional trade, simple and complex value chains, the evolution of the trade network structure, and the changes in the weighted out degree and weighted in degree of the trade network. It provides a new perspective for the development and evolution of trade networks. At the same time, this article explains that further deepening participation in the global value chain and maintaining the stability of the value chain system will help China improve its position in the global value chain system against the background of the COVID-19 and trade protectionism.

2. Literature Review

The social network analysis method has been widely used in the field of international trade. It describes the social structure and characteristics of group relations through points and lines. At present, the research on the temporal and spatial pattern evolution, topological structure and influencing factors of the global trade network mainly starts from the overall pattern. Chen Yinfei (2011), Zhang Qin et al. (2012) build a global trade network based on the total trade value and study the evolution of its network structure; Cheng Shujia and Wang Zhaojun (2011), Sun Xiaolei et al. (2012), Liu Jian (2013), Liu Jinsong (2016), Wang Xiang et al. (2018) conducted research based on specific manufacturing or service industry sectors, such as characterizing the evolution of global trade networks of commodity industries such as oil and natural gas.

From the perspective of total value trade, there have been numerous litera-

tures systematically discussed. Chen Yinfei (2011) used total value of import and export data to represent bilateral trade volume between countries, and constructed a total value trade network. Through network characteristic indicators such as density and centrality, as well as core-periphery analysis, he found that while the Internet status of the United States continues to decline before and after the subprime mortgage crisis, the network status of Japan, Germany, Britain, France, and the BRIC countries have all increased significantly (Zhang & Li, 2012). Through the establishment of a total value trade network of the top 50 international trades from 2001 to 2010, network characteristic indicators, "core-periphery" analysis and structural hole analysis, he found that although our country's position in the trade network continues to increase, there is still a gap between China and the United States, Germany and other countries, and China needs to further enhance the right to speak and influence. Yang Wenlong et al. (2018) constructed a total value trade network of countries along the "Belt and Road". Through the gravity model and QAP analysis, they found that the network has a small-world nature. The spatial structure of the network shows the characteristics of "hybrid" network structure with China as the core and Russia, ASEAN and UAE as the secondary core. There are also some studies that divide the global trade network into different regional trade networks based on the construction of a global trade network, and analyze and compare the structural differences between the global network and the regional network (Xu et al., 2015; Song et al., 2017; Jiang et al., 2018; He et al., 2019). However, the statistical methods based on total value trade have serious shortcomings and cannot reflect the true situation of trade gains (Wang et al., 2015), especially in industries with high value-added differences in various links such as ICT. It is necessary to portray the regional trade network from the perspective of global value chain.

Therefore, based on the UIBE GVC Indicator database, this article uses the WWZ accounting method to calculate the trade value, and uses the social network analysis method to construct the Asia-Pacific ICT industry trade network structure and evolution process.

3. Construction of the Asia-Pacific Trade Network for the ICT Industry

3.1. Network Construction Method

This article mainly constructs a collection of trade network relationships among 17 countries and regions in the ICT industry in the Asia-Pacific region. According to the description method of the complex network, the vector $V_i = [v_i](i = 1, 2, \cdots, n)$ represents the exporting country, the vector $V_j = [v_j](j = 1, 2, \cdots, n)$ represents the importing country, and the weight matrix $W = [W_{i,j}](i = 1, 2, \cdots, n; j = 1, 2, \cdots, n)$ represents the domestic value added of trade between the two countries. In the weight matrix W, the weighted out-degree W_i^{out} and the weighted in-degree W_i^{in} are the domestic added value of exports from country V_i to country V_j and from country V_j to country V_i. V_i, V_j

and W together form the Asia-Pacific trade network of the ICT industry, denoted as $G = (V_i, V_j, W)$.

In order to further compare the differences of the Asia-Pacific trade network of the ICT industry from the perspective of global value chain and total value trade, this paper constructs a regional trade network in the three dimensions of traditional trade, simple value chain trade and complex value chain trade from 2005 to 2015. It also uses Gephi software to visualize the three-dimensional trade network and draw the topological map of the trade network. Furthermore, this article studies the evolution and structural characteristics of the Asia-Pacific trade network of the ICT industry by combining the weighted out-degree and weighted in-degree change trends of various countries (regions).

3.2. Data Sources

Shen Haoran (2019) believes that the ISIC classification only includes the ICT service industry in the ICT industry, and is not enough to represent the development of the entire ICT industry. The OECD classification not only includes the ICT service industry, but also includes the ICT industry manufacturing industry, and the data is more comprehensive. Therefore, according to the definition of the ICT industry in the OECD database, which reflects data on the number of countries or regions, the number of industrial sectors included, the time span, and processing trade. this article screened the D26, D61, D62T63 classification data in the OECD-ICIO 2018 sub-table to represent the entire ICT industry. Among them, the meaning of each classification is shown in Table 1.

The UIBE GVC Indicators is a non-profit database for academic research, which provides trade in value added indicators and global value chain (GVC) related indicators. It is a secondary database, which is processed based on the public released ICIO tables. This article uses the UIBE GVC Indicators database, which is processed based on the public released OECD-ICIO2018 tables, and the WWZ algorithm proposed by Wang et al. (2013) and Wang Zhi et al. (2015). Based on the input-output perspective, further decomposition of total trade exports is achieved by diverting intermediate goods trade, and finally the decomposition of one country's exports to another country is expressed as:

$$\text{TEX} = \underbrace{\text{DVA}_{\text{FIN}} + \text{DVA}_{\text{INT}} + \text{DVA}_{\text{INTREX}}}_{\text{DVA}} + \underbrace{\text{MVA} + \text{OVA}}_{\text{FVA}} + \underbrace{\text{DDV} + \text{FDC}}_{\text{PDC}} + \text{RDV} \quad (1)$$

Among them, DVA_{FIN} represents the domestic value-added of a country's final

Table 1. Definition of ICT industry.

ICT industry classification	OECD-ICIO 2018 number	Subdivided industries
ICT industry manufacturing	D26	Computer, electronic and optical products
ICT service industry	D61	Telecommunications
	D62T63	IT and other information services

export products, DVA_{INT} represents the domestic value-added of intermediate products absorbed by the direct importing country, DVA_{INTREX} represents the domestic added value of intermediate products produced by the direct importing country and exported to a third country and absorbed by a third country. These three parts constitute the domestic value-added DVA absorbed by foreign countries; MVA represents the value-added implied by the importing country in exports, and OVA represents the third-country value-added implied by the exports. These two parts constitute the foreign value-added FVA; RDV represents the domestic value-added returned and absorbed by the country. In addition, the export composition also includes the pure double counting DDC of the domestic account and the pure double counting FDC of the foreign account. These two parts constitute the pure double counting part of the PDC.

In addition, Wang et al. (2017) divided production activities into four categories based on whether the production process involves the participation of two or more countries, and the three types of production activities involving international trade can be represented by DVA in formula (1).

According to the meaning of the above DVA sub-items, it can be found that DVA_{FIN} represents traditional international trade, DVA_{INT} represents simple global value chain trade, and DVA_{INTREX} represents complex global value chain trade. Based on this, this paper constructs a three-dimensional domestic value-added regional trade network of traditional trade, simple value chain trade, and complex value chain trade, and conducts research on the evolution of ICT industry trade networks in 17 countries or regions in the Asia-Pacific region from 2005 to 2015.

3.3. Construction of Nodes and Edges

1) Construction of nodes

This article will take each country or region as a vertex in the trade network, and construct the node of the trade network with 17 countries and regions in the Pacific Rim and Southeast Asia. The size of the node represents the total bilateral domestic value added and represents the position of the country (region) in the Asia-Pacific trade network. The calculation formula for the size of node i is:

$$DVA_{FIN}^{i} = \sum_{j}^{n} DVA_{FIN}^{out} + DVA_{FIN}^{in} \tag{2}$$

$$DVA_{INT}^{i} = \sum_{j}^{n} DVA_{INT}^{out} + DVA_{INT}^{in} \tag{3}$$

$$DVA_{INTrex}^{i} = \sum_{j}^{n} DVA_{INTrex}^{out} + DVA_{INTrex}^{in} \tag{4}$$

Among them, Equations (2) (3) (4) respectively calculate the node size in the three dimensions of traditional trade, simple value chain trade and complex value chain trade; $DVA_{FIN}^{out}, DVA_{INT}^{out}, DVA_{INTrex}^{out}$ represents the domestic value-added of exports from country i (region) to country (region);

$DVA_{FIN}^{in}, DVA_{INT}^{in}, DVA_{INTrex}^{in}$ represent country (region) j to i. The domestic value-added of exports from countries (regions).

2) Construction of edge

In this paper, the domestic value added of each country (region) is used as the weight of the edge, and the trade volume between the nodes in the trade network is used as the edge, and the nodes in the trade network are connected. The thickness of the edge indicates the closeness of trade ties between the countries (regions) at both ends of the connection, and the number of edges indicates the number of trading partners in each country (region). In this article, 17 countries (regions) all have bilateral trade, so this article will take the thickness of edges as the main indicator to analyze the status changes of each country (region) in the process of network evolution. The thickness of the edge is calculated from the sum of the weighted out-degree and the weighted in-degree of each country (region). The calculation formula for the thickness of the edge connecting node i and node j is:

$$W_{i,j} = W_i^{\text{out}} + W_i^{\text{in}} \tag{5}$$

In this formula, W_i^{out} represents the weighted outdegree, and W_i^{in} represents the weighted indegree.

4. Characteristics and Evolution Trends of the Asia-Pacific Trade Network of the ICT Industry

4.1. Characteristics of the Total Import and Export Volume of the Asia-Pacific Trade Network of the ICT Industry

1) Characteristics of the total import and export volume of traditional trade

The total volume of the traditional Asia-Pacific trade network of the ICT industry features steady and continuous improvement, relatively stable development, and relatively close trade ties within the region. The total volume of imports and exports of traditional trade has regional characteristics, which can be seen in three levels: core, sub-periphery, and marginal (Figure 1). China and the United States are at the core of the traditional total trade volume; Canada, Japan, South Korea, India and Taiwan area, PRC[1] are in the sub-peripheral area of the traditional total trade volume; while Russia and other ten countries and regions are at the
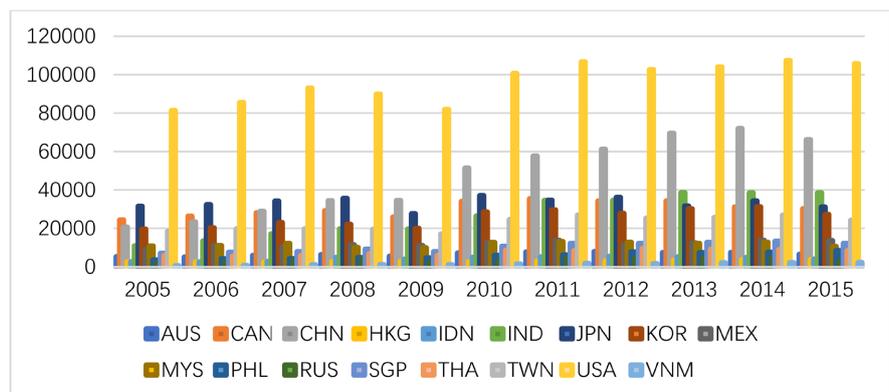
Figure 1. Total import and export volume of traditional trade (FIN) in the ICT industry in Asia-Pacific economies.

[1]All TWNs appearing in this paper refer to Taiwan area, PRC.

edge of the total traditional trade volume.

2) Characteristics of total import and export volume of simple and complex value chain trade

The trend of changes in the total import and export volume of simple and complex value chains is basically stable. The characteristics of increased network closeness are consistent with traditional trade perspectives, and both have an obvious "core-sub-periphery-periphery" structure. However, comparing traditional trade, simple value chain and complex value chain, the following differences can be found: first, China has grown more than other countries (regions) in the Asia-Pacific region in simple and complex value chain trade, and has always maintained the number one position. Therefore, the network importance of China's ICT industry is underestimated by traditional estimation methods. As shown in **Figure 2**, through the development of trade in intermediate goods, China's simple value chain import and export trade has seen a relatively large increase. In 2011, China's simple value chain trade volume exceeded that of the United States, and it has gradually become the regional trade center of the ICT industry in the Asia-Pacific region. Second, the importance of key nodes from the perspective of the value chain is slightly different. The core countries (regions) of the simple value chain trade network are still China and the United States, but in the complex value chain trade network, China is even more at the core. Japan is at the secondary edge of the simple value chain network, but its importance in the complex network has diminished. Third, the complex value chain has observed the impact of the 2008 financial crisis on the ICT industry and the recovery process. As shown in **Figure 3**, one year after the crisis broke out, trade has basically recovered. During this period, China has taken active countermeasures, increased currency injection to stimulate the economy, and restored the total volume of value chain trade imports and exports to a steady growth.

4.2. Analysis of the Characteristics of the Asia-Pacific Trade Network of the ICT Industry

In the Asia-Pacific trade network of the ICT industry, the status and importance
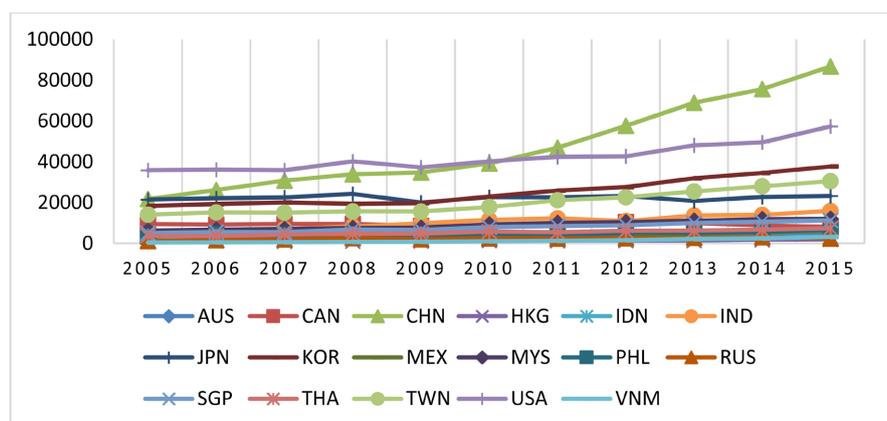
Figure 2. Line chart of total import and export volume of simple value chain trade (INT) in the ICT industry in Asia-Pacific economies.
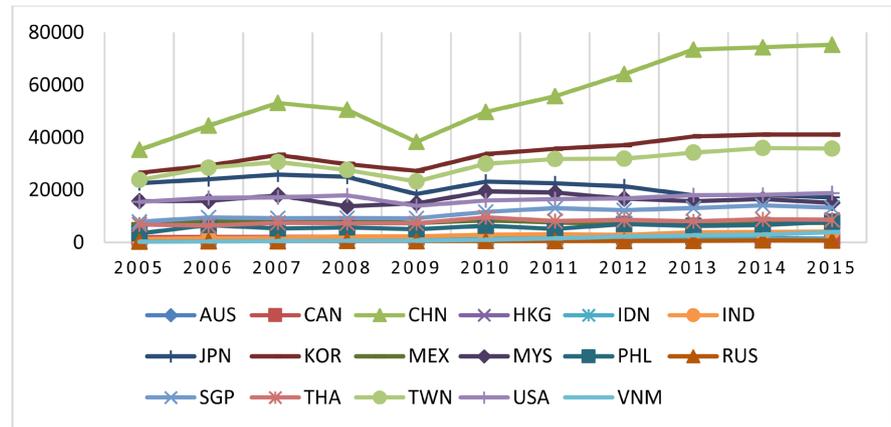
Figure 3. Total import and export volume of ICT industry complex value chain trade (IN-Trex) in Asia-Pacific economies.

of a country (region) can be measured by the network weighting degree. This article uses weighted in-degree and weighted-out degree to discuss the status of different countries (regions) in the Asia-Pacific trade network of the ICT industry. Among them, the weighted in-degree is the measurement of the total domestic value-added imported by the country (region) by other trading partners in the network, and the weighted-out degree is the total domestic value-added exported by the country (region) to other trading partners in the network. Take a measurement. Table 2 shows the top 10 countries (regions) with weighted in-degrees and weighted-out degrees in traditional trade networks, simple value chain networks, and complex value chain networks in the Asia-Pacific region of the ICT industry in 2000, 2009, and 2015, and their corresponding domestic value added.

From the perspective of the traditional trade network, the United States has always ranked first in terms of weighted output, and the domestic value-added contained in its traditional trade network is the highest, which is basically in line with its position in the ICT industry. The three countries of China, Japan and India have more obvious changes, and most of the other countries (regions) have basically maintained their weighted out-of-degree rankings. With the continuous rapid development of China's economy, increased investment in R&D, and the signing of the ITA2.0 (expansion) under the WTO framework has made the traditional trade network rank 7th, reaching the level of US $7.478 billion in 2015. However, China is still in the middle reaches of the Asia-Pacific region; Japan is dependent on foreign trade due to the long-term impact of the bubble economy, and the domestic value added of its traditional trade exports has declined significantly after 2013, gradually falling from second to fifth. It can be seen that the weighted out degree has played a major role in promoting the decline of Japan's network status; India is one of the important trading partners of the US ICT industry, and it has also seen rapid growth driven by emerging Asian markets, especially the IT industry. The rapid development of the traditional trade network has accelerated the development of the traditional trade network, and the

Table 2. Analysis of the node status of the Asia-Pacific trade network of the ICT industry (top 10).

Year	Traditional trade network (FIN)			Simple GVC Network (INT)			Complex GVC network (INTrex)		
	Rank	Weighted in-degree	Weighted out-degree	Rank	Weighted in-degree	Weighted out-degree	Rank	Weighted in-degree	Weighted out-degree
2005	1	USA 44334	USA 36950	1	CHN 20334	USA 19047	1	CHN 34475	JPN 20066
	2	CAN 19390	JPN 19831	2	USA 16770	JPN 13988	2	MYS 11099	KOR 16581
	3	CHN 17718	KOR 15022	3	JPN 7451	KOR 11801	3	KOR 9950	TWN 15692
	4	JPN 11693	TWN 12684	4	CAN 7154	TWN 10592	4	TWN 8171	USA 12755
	5	MEX 6631	IND 9425	5	KOR 6486	MYS 4716	5	MEX 6616	SGP 6844
	6	TWN 5837	MYS 7849	6	MEX 3744	SGP 4354	6	THA 4035	MYS 4630
	7	KOR 4525	SGP 6307	7	TWN 3512	IND 2971	7	USA 2695	THA 2842
	8	AUS 4211	CAN 4951	8	AUS 3046	THA 2295	8	JPN 2478	PHL 1554
	9	MYS 2967	THA 3615	9	PHL 2270	CAN 2229	9	PHL 1903	IDN 1163
	10	THA 2362	CHN 2915	10	IND 1910	CHN 1384	10	CAN 1504	CHN 845
2009	1	USA 43100	USA 38770	1	CHN 32623	USA 17582	1	CHN 37231	KOR 17314
	2	CHN 30576	IND 17242	2	USA 19684	KOR 14512	2	KOR 9986	JPN 16767
	3	CAN 20714	KOR 16717	3	JPN 6302	JPN 13760	3	MYS 9659	TWN 16276
	4	JPN 10906	JPN 16711	4	CAN 5849	TWN 13132	4	MEX 7071	USA 11376
	5	MEX 8289	TWN 13608	5	KOR 5168	IND 7228	5	TWN 6996	SGP 7769
	6	AUS 4362	MYS 7415	6	AUS 3392	SGP 5565	6	THA 3961	MYS 5255
	7	TWN 3524	SGP 6499	7	MEX 3057	MYS 5388	7	USA 2562	THA 3337
	8	KOR 3185	CAN 5150	8	IND 2520	THA 2996	8	PHL 2272	PHL 2742
	9	MYS 2462	CHN 3981	9	TWN 2498	CAN 2786	9	JPN 1697	IND 1628
	10	IND 2402	THA 3908	10	MYS 2250	PHL 2296	10	SGP 1468	CHN 1066
2015	1	CHN 58716	USA 58083	1	CHN 80487	KOR 31537	1	CHN 72662	KOR 30168
	2	USA 47657	IND 34743	2	USA 32396	TWN 28529	2	KOR 10925	TWN 29784
	3	CAN 26829	KOR 21771	3	JPN 6699	USA 24979	3	MYS 7994	JPN 15527
	4	JPN 16355	TWN 20187	4	KOR 6159	JPN 16552	4	MEX 6794	USA 14421
	5	MEX 10768	JPN 14686	5	CAN 5614	IND 12791	5	TWN 6996	SGP 10355
	6	KOR 5429	SGP 9985	6	MYS 3591	SGP 9572	6	USA 4365	MYS 7134
	7	AUS 4799	CHN 7478	7	AUS 3417	MYS 8409	7	THA 3899	THA 4742
	8	TWN 4032	MYS 7380	8	MEX 3368	CHN 6209	8	PHL 3210	PHL 4669
	9	PHL 3810	THA 5667	9	IND 3073	THA 5698	9	SGP 2951	IND 3265
	10	IND 3740	PHL 4597	10	PHL 2174	PHL 4813	10	VNM 2946	CHN 2640

domestic value added of traditional trade exports has increased rapidly, that is, it has increased from US $9.425 billion in 2005 to US $34.743 billion in 2015, and the ranking has been increased from fifth to second.

The weighted in-degree changes in China, India, and Taiwan area, PRC are

relatively large. The added value of China's imports accounted for a relatively high proportion of the total value of imports and exports, indicating that China's bilateral trade network has grown rapidly, and that the added value of imports from traditional trade networks is an important force that ensures China's growth as a secondary core in the network. The degree of India's weighted in-degree has increased, but it is not as good as that of exports. It only increased from US $1.505 billion in 2005 to US $3.74 billion in 2015; Taiwan area, PRC's weighted in-degree ranking has dropped significantly, and it still forms a pole in the traditional trade network with China and South Korea.

From the perspective of simple and complex value chain trade networks, from 2005 to 2015, the United States, Japan, South Korea, and Taiwan area, PRC have always occupied the top four positions in the weighted out-degree of the simple and complex value chain trade networks. This shows that these four countries (regions) have always been strong exporters of ICT industry in the Asia-Pacific region, providing a large number of intermediate exports to other countries (regions). In addition, these four countries (regions) have always had a strong competitive relationship. Due to the continuous strengthening of trade links between Taiwan area, PRC, South Korea and Mainland China, after 2009, the weighted out-of-complex value chain and simple value chain trade network began to widen the gap with Japan. Therefore Taiwan area, PRC and South Korea has become China's two most important trading partners. In the simple trade export degree, Taiwan area, PRC rose from 4th to 2nd, South Korea rose from 3rd to 1st, and China rose to 8th, forming a regional center in the simple value chain trade network. However, Japan's weighted out-degree ranking dropped from 2nd to 4th, and was surpassed by South Korea and Taiwan area, while the US's weighted out-degree ranking dropped from 1st to 3rd, indicating the two countries' status of the simple value chain network has declined, which to a certain extent led to the change of the simple value chain trade network from a unipolar situation in 2005 to a bipolar situation in 2015. In the complex value chain trade network, China's weighted out-degree ranking has always been around 10th, United States' network core position is still very strong for its weighted out-degree ranking of the is second only to Japan, South Korea, and Taiwan area, PRC, and is steadily ranked 4th.

In simple and complex value chain trade networks, the trend of weighted in-degree rankings is quite different from the weighted out-degree rankings. The top three countries (regions) in the weighted in-degree table of simple value chain trade networks are China, the United States, and Japan. The top three countries (regions) in the weighted in-degree of complex value chain trade networks are China, South Korea and Malaysia. China has always been the largest importer of ICT industry simple value chain trade in the Asia-Pacific region, because a large amount of processing trade has promoted China to become the largest regional center. The United States and South Korea have maintained their simple and complex top three positions respectively. Therefore, China and

the United States have formed a bipolar situation of simple value chain trade networks. In the simple value chain trade network weighted in-degree, South Korea's weighted in-degree has gradually surpassed that of Japan in the past 11 years, which can explain the changes in the status of the two countries in the simple value chain network to a certain extent. In addition, Malaysia's weighted in-degree ranking has risen to sixth, making it a more important country in the sub-peripheral region; Malaysia has become a more important country in the core region in the weighted in-degree of complex value chain trade networks. This status of Malaysia is quite different from that in the traditional trade network and simple value chain trade network.

4.3. Analysis on the Evolution Trend of the Asia-Pacific Trade Network of the ICT Industry
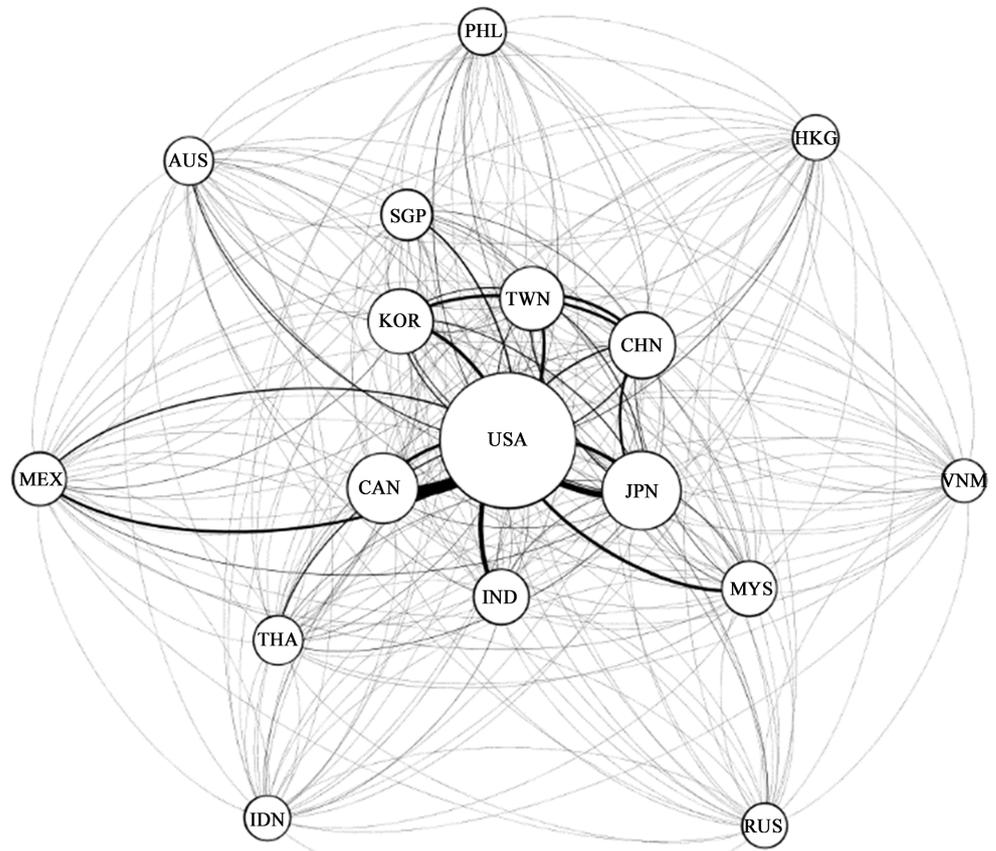
1) Traditional trade network

As shown in Figure 4, the ICT industry's Asia-Pacific traditional trade network structure center is constantly changing, and the regional center is changing from unipolar to multipolar. Before 2009, the United States was the regional center of the traditional trade network structure. Trade in the region basically revolved around the United States while the degree of trade linkages varies. Canada and India trade the most closely with the United States, followed by China, Japan, South Korea, and Taiwan area, PRC, while the trade links with Singapore, Mexico, Malaysia and the core regional economies are relatively weak, and seven countries and regions including Russia are in a marginal position. The occurrence of the subprime mortgage crisis in 2008 has changed the regional structure, for China's positive incentive policies has enhanced its ICT industry importance in the network. In 2009, the total import and export volume of China's traditional trade network surpassed Japan for the first time.

In 2015, the structure of the traditional trade network of the ICT industry in the Asia-Pacific region has undergone fundamental changes: the traditional trade of some countries in the region has shifted; the degree of interdependence of the trade network has been scattered; and the trade network has developed from one center to multiple core regions. The first is the core area of the trade network centered on the United States, including Canada, India, Mexico and other countries. China's economy continues to improve with the ICT industry further opened, and the import and export trade continues to increase, attracting countries and regions in the region. Therefore, the focus of trade has gradually shifted to China, forming the second core area of trade network centered on China, including South Korea, Japan, Taiwan area, PRC and other countries and regions.
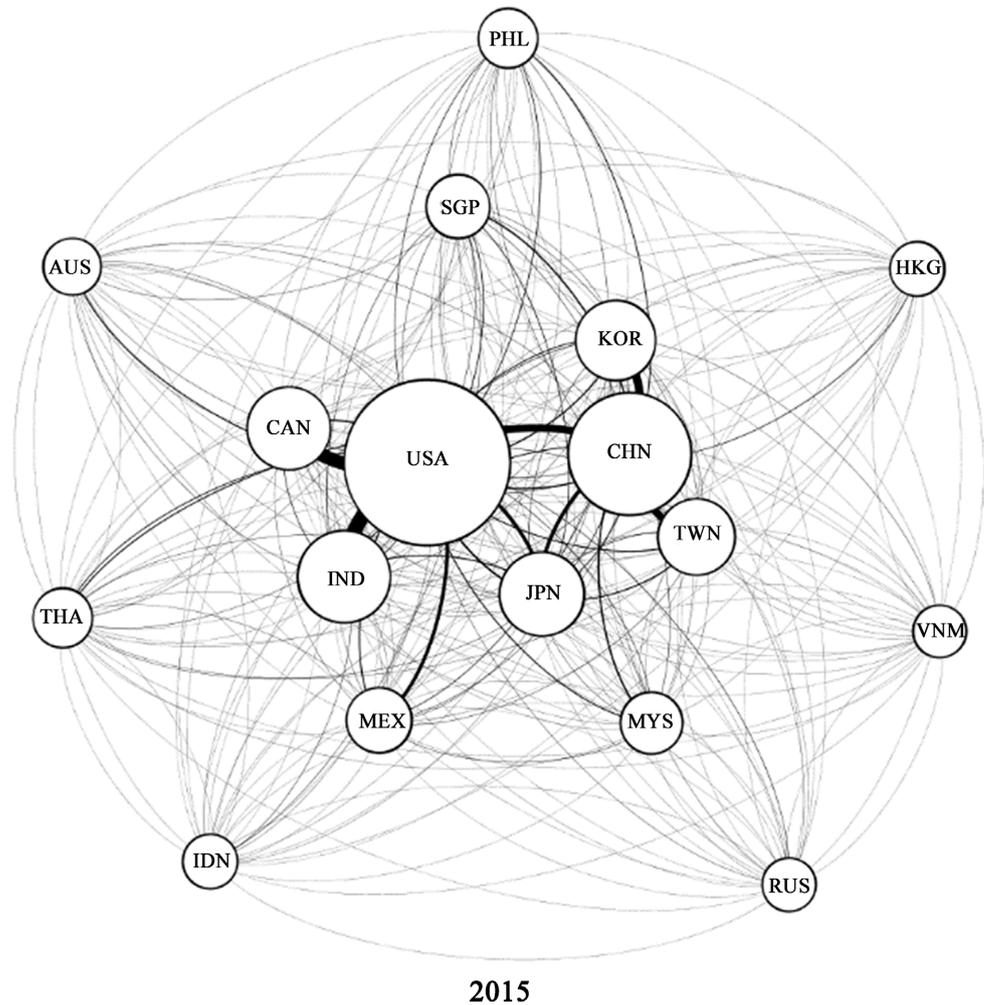
2) Value chain trade network

As shown in Figure 5, in the complex value chain trade network, China, as the center of the trade network, has the closest ties with Japan, South Korea, Taiwan area, PRC and the United States, forming the core area of the complex value chain trade network, while Mexico, the Philippines, Singapore and Thailand
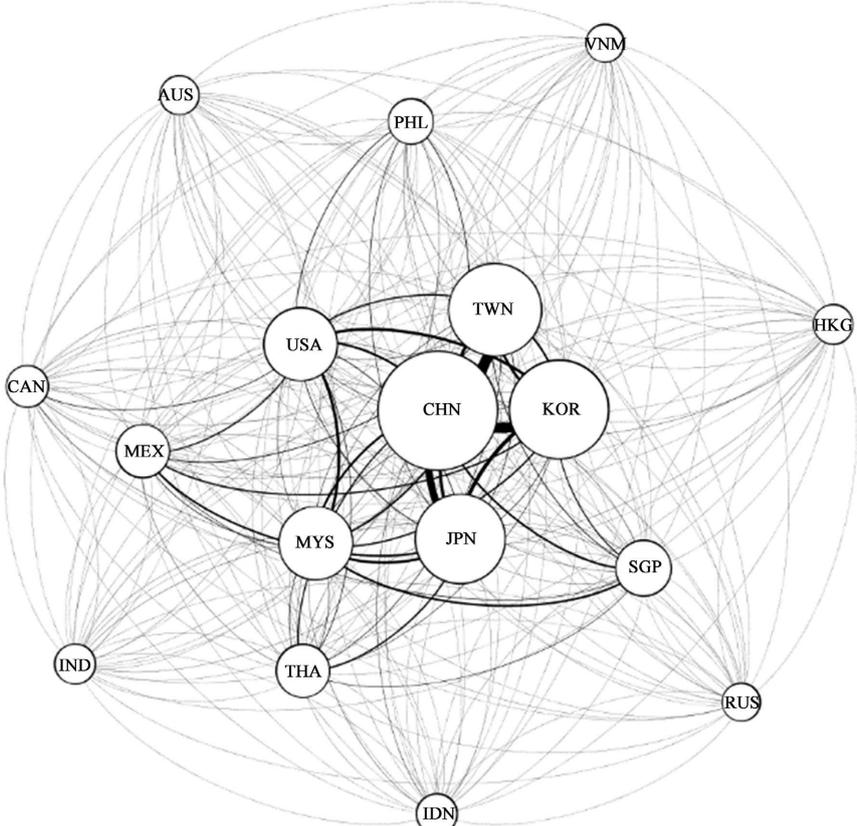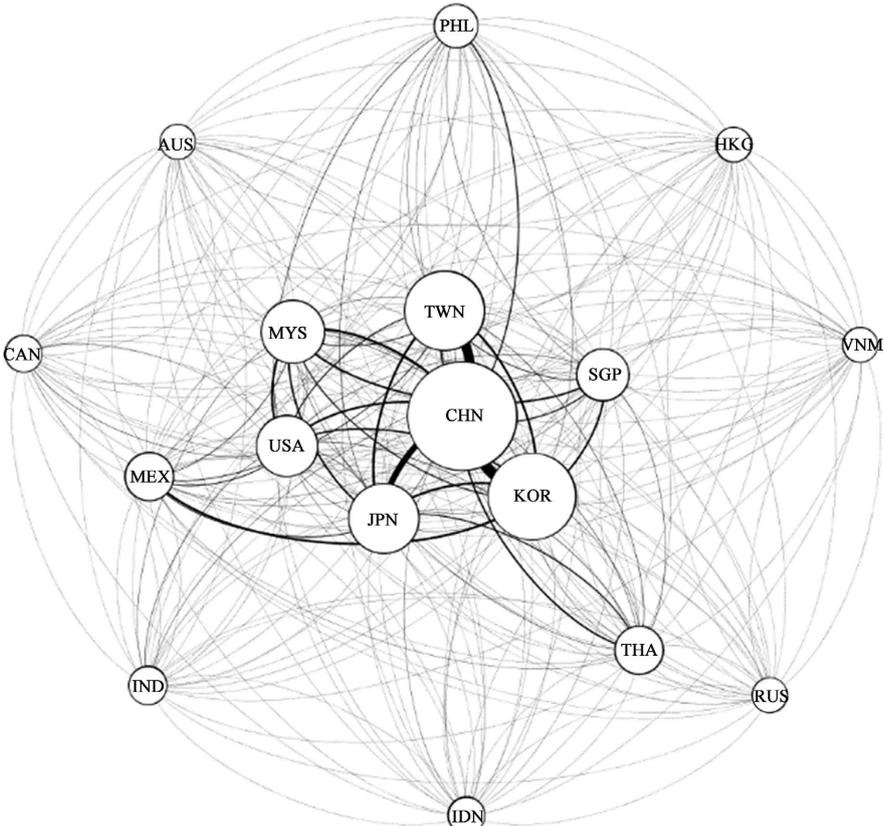
2005
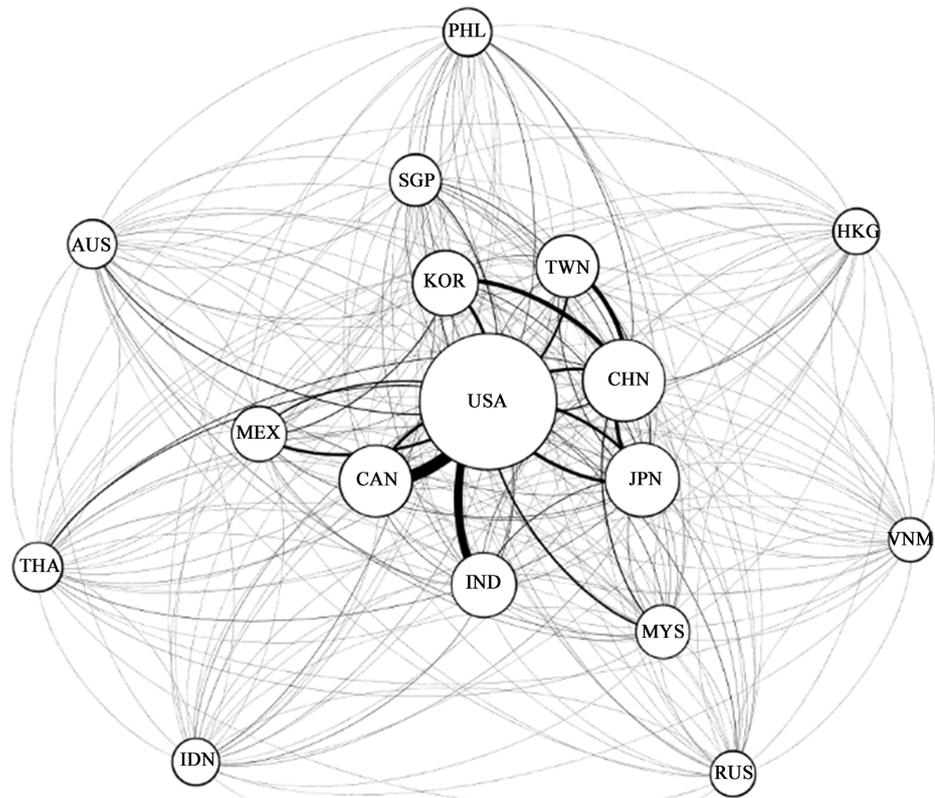
2009

2015

Figure 4. The evolution trend of traditional trade networks (2005, 2009, 2015).

have slightly weaker trade intensity with China and are in the sub-peripheral area. The other seven countries (regions) are at the edge of the network.

After 2009, the structure of the complex value chain trade network has undergone certain changes. First of all, the trade intensity between South Korea, Taiwan area, PRC, and China is gradually widening the gap with Japan. These two economies have become China's most important trading partners; although the United States and Malaysia still form the core area of the network around China, the volume of trade in Malaysia surpassed the United States for the first time, and its status rose in the Asia-Pacific region; the sub-peripheral countries, dominated by Mexico, Thailand and Singapore, also have a tendency to move closer to the core region. In 2015, most countries (regions) in the Asia-Pacific complex value chain trade value chain network structure of the ICT industry stabilized, and their statuses have not changed significantly. In the complex value chain trade network, only Japan further declined in 2013, from China's most important trading partner in 2005 to a position close to that of the United States and Malaysia. The trade ties between mainland China, South Korea and Taiwan

2005

2009
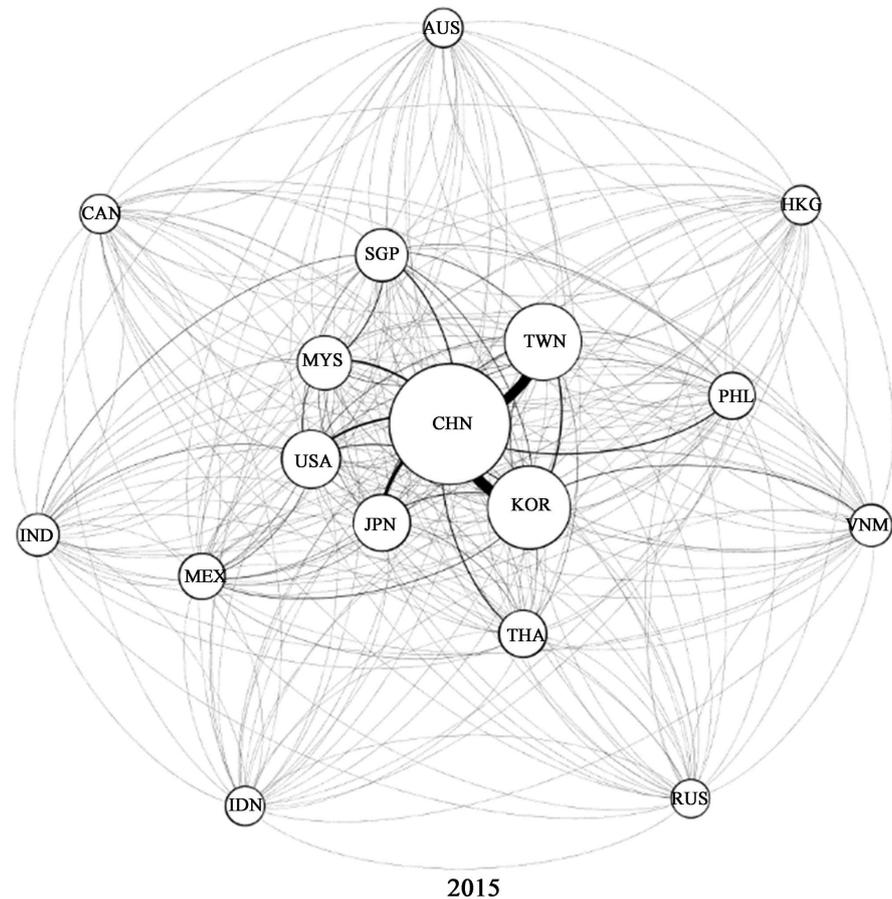
2015

Figure 5. Evolution trend chart of complex trade network (2005, 2009, 2015).

area, PRC, have been strengthened day by day, and these three economies have gradually formed secondary core areas of complex value chain trade networks outside the United States and Japan.

5. Conclusions and Recommendations

This article uses social network analysis methods, based on the added value data of the World Input-Output Table from 2005 to 2015, to portray the Asia-Pacific trade network of the ICT industry. It also analyzes the variation trend of traditional trade, simple and complex value chain trade, the evolution of trade network structure, the weighted out-degree and the weighted in-degree of trade network and the following conclusions are drawn.

First, the overall structure of the ICT industry trade network in the Asia-Pacific region is stable. During the evolution of traditional trade networks and value chain trade networks, the development of traditional trade networks and value chain trade networks are generally stable, and regional trade links are gradually becoming closer; both traditional trade networks and value chain trade networks reflect regional characteristics, which is consistent with the research conclusions of the core—sub-periphery—peripheral trade network characteristics reflected in the previous literature; traditional trade networks and value chain trade net-

works will gradually recover when they are subjected to external shocks, and the impact of the shocks is basically regional, temporary and phased, but the traditional trade network and the value chain trade network reflect slightly different recovery status.

Second, the importance of ICT industry trade network nodes in the Asia-Pacific region has changed. Traditional trade networks and value chain trade networks are evolving, and their structures are constantly changing, showing a situation of ebb and flow, with regional centers changing from unipolar to multipolar. The center of the traditional trade network is gradually being weakened or replaced, and the degree of dependence on the trade network is scattered; the position of the trade network center of the value chain is also changing. The ICT industry in the Asia-Pacific region has formed the core area of the trade network centered on the United States and China in the traditional trade network; in the process of changes in the simple and complex value chain trade network structure, China has responded to crises by stimulating the economy, and increasing trade in intermediate goods, which enabling China to surpass other countries (regions) in the Asia-Pacific region in value chain trade and become the center of the value chain trade network.

Third, the trade network of the ICT industry in the Asia-Pacific region has strengthened. In the evolution of traditional trade networks and value chain trade networks, trade networks are interdependent and closely connected around the core of the region. The closeness and strength of the connections mainly depend on the regional position of the trade network and the economic policies of the core countries and strong development momentum. China has taken active measures in response to external shocks and strengthened cooperation, increased currency injection to stimulate the economy and lead the world economy out of difficulties, thus countries have maintained close trade ties with China in order to get rid of these difficulties. Therefore, the value-added trade network of the ICT industry value chain in the Asia-Pacific region has shown rapid growth, and it maintains the strongest trade links and high trade intensity in the network with other countries, and has a relatively central position in the value chain trade network.

Based on the analysis and research conclusions of this article and in order to promote the development of value-added trade in China's ICT industry, this article puts forward the following suggestions: first, China should base on the domestic trade network, to advance the domestic economy, industrial chain, and technological innovation, in order to form its own central network nodes, get rid of excessive dependence on a single international trade network. Also China needs to seek diversified international cooperation and multi-regional cooperation so as to reduce the impact of external shocks. Second, promote the international regional cycle, prioritize the development of trade network cooperation with neighboring regions with strong interdependence and strong trade complementarity. Additionally, China needs to shorten supply chains, extend value

chains, ensure a virtuous circle of trade, and improve trade network connections. Third, ensure the continuous opening of the ICT industry, connect with high-level free trade rules, enhance the core competitiveness of the domestic ICT industry, increase cooperation between enterprises, extend the industrial chain, and form closer complementary relationships.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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