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The research on the impact of regional trade network relationships on value chain resilience in China’s service industry

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The research on the impact of regional trade network relationships on value chain resilience in China's service industry

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Keywords: Regional trade network relationships; trade network relationships; service industry; value chain resilience

1. Introduction

The Global Value Chain (GVC) is a central mechanism for driving the world economy (Antràs & Chor, 2013). But while it has had positive effects, it has had some negative ones. Economic globalization has driven countries to take advantage of their comparative advantages to locate their production chains on a global scale, which has resulted in increased production efficiency and lower production costs. According to data published in *GVC Development Report 2021: Beyond Production*, GVC participation in the world's economies has risen from 35.2% to 44.4% between 1995 and 2020, which was even up to 49.3% in 2018. Moreover, the contribution of GVC to GDP rose from 9.6% to 12.1%, peaking at 14.6% in 2018. Looking at specific countries, from 2000 to 2019, GVC participation increased in almost all countries. For instance, GVC participation in Germany has increased from 45.6% to 52.4%. The GVC plays a significant role in promoting global economic growth and development.

However, the vulnerability of the GVC when subjected to adversity events has also had a significant impact on the countries involved in the chain. At the end of 2019, the outbreak of COVID-19 led to repeated dysfunctional operations and even operational disruption crises in the GVC of numerous

industries. Additionally, Sino-US trade conflicts, the Ukraine Crisis, the Israel-Palestinian conflict, and other great power games, geopolitical conflicts, and other old and new issues are interlaced, which lead to extreme instability in the GVC, the governments have introduced various policies to “reverse globalization” or “de-globalization” (Qu & Yang, 2022). The fact that trade directly related to GVC accounts for 2/3 of global trade, has led many to worry about the risks and future of GVC, especially the service industry value chain, whose development not only reflects the breadth and depth of their specialized division of labor, but also affects the synergy and integration with other industries and the overall division of labor. However, due to the high mobility and embeddedness of the service industry, uncertainties can significantly impact the service industry value chain. Therefore, how to enhance the resilience of China's service industry value chain in the face of the impact of adversity is a challenge of development that needs to be urgently tackled in the critical period of accelerated reconstruction of the GVC.

Adverse event shocks have led to the "short-chain" of the service industry value chain, bringing risks of "decoupling" and "chain-breaking", while at the same time, giving rise to more intraregional trade and the gradual accentuation of the "regionalization" of value chains. Regional value chain, as a third chain independent of global and domestic value chains, becomes a more important link in the dual circulation. Besides, the high-quality co-construction of the regional value chains(RVC) circulation system will help industries get rid of the low-end lock-in of the GVC, which not only provides a new path for the service industry value chain to complete decoupling and restructuring and carry out structural evolution but also reserves core competencies for adapting to shocks, enhancing resilience and realizing high-quality development (Pei & Liu,2020; Zhen & Wang,2022). However, the net effect of RVC works on the basis of trade relations. Trade relations are not only a vehicle for the release of positive spillover effects, but also have a scaling impact on the effects through transmission. In particular, against the backdrop of increasingly complex trade associations and the dominance of trade relations over the healthy development of the global economy, regional trade network relationships have gradually become a central influence in enhancing the structural value chain resilience, improving the operational value chain resilience and strengthening the technological value chain resilience.

Therefore, under the framework of RVC, this article explores its impact on the resilience of China's service industry value chain from the perspective of trade relations. This will not only enhance the ability of China's service industry value chain to cope with risky shocks, but also be of great significance in accelerating the construction of a strong service trade country, unimpeded dual circulation, and positively and effectively responding to the challenge of "decoupling and chain-breaking".

2. Literature review

GVC resilience is the ability of the GVC to forecast, respond to, recover from, and sustain growth when dealing with external shocks or risks, thereby maintaining the stability and security of GVC operations (Hohenstein et al., 2015). In recent years, scholars have focused on in-depth discussions on the destructive structural reconfiguration of GVC triggered by Covid-19, arguing that the innovation inertia of Chinese enterprises and their excessive dependence on the dominant enterprises in the value chains have exacerbated the risk of chain-breaking and that enhancing the resilience of the system in coping with the shocks of future emergencies will be the main direction of reconfiguration (Sun & Wei, 2020;

Zhen et al., 2022). Based on this, scholars have quantitatively analyzed the value chain resilience from the perspectives of micro-enterprises and the macro-global perspective (Ambulkar et al.,2015; Yang & Zheng,2023), and in the context of the rapid development of the digital economy, they have concluded that the "snowball effect" of the transmission of the GVC crisis has been amplified in the digital economy, which has aggravated the shocks of the crisis on the security and stability of the value chain (Tang et al., 2019; Yang & Zheng,2023). However, some scholars have argued that digital platforms can enhance the resilience of value chains to systemic risks by collecting and integrating massive amounts of data and anticipating shocks, generating response mechanisms (Gereffi, 2018). To further enhance value chain resilience, scholars have selected agricultural and industrial value chains as their objects of study (Adu et al., 2021; Claudia & Dagmar, 2022; David et al., 2022), enriching the argumentation from the perspective of value chain governance and supply chain construction (Levalle & Nof,2015; Zhen & Wang,2022). Zhen Zhen et al. (2022) even condensed the dynamic evolutionary process of value chain system resilience spiraling upwards after being hit by adversity events from the path perspective.

With the deepening development of economic globalization, trade associations between countries have become increasingly close, and crisscrossed trade relations have gradually developed into trade networks (Ma et al., 2016). Combined with the complex context of trade networks, scholars have argued that trade network relationships are not only the medium through which the above shocks are transmitted to the value chain but also an important vehicle for value chain fragmenting and restructuring (Ren et al., 2023; Zuo et al., 2023). In order to fully analyze value chains, it is important to incorporate the intricate trade relations between countries into the study (Fagiolo et al., 2009). Ma Shuzhong et al. (2016) examined the impact of a country's agricultural trade network characteristics on its position in the agricultural value chain division of labor from an agricultural trade network perspective. The study found that network centrality, network relation intensity, and network heterogeneity have robust and significant contributions to a country’s position in the global agricultural value chain division of labor. With the proliferation of RTA, the world is increasingly multipolar(Chen, 2011). Zuo Bing et al. (2023) argue that the RTA network is an important national strategy for China to build an open economy and a significant way to promote an effective connection between domestic and international economic circulations. Many scholars have deepened their research from a regional perspective. Shen, Minghui et al. (2023), focusing on East Asian RVC, argued that, it can play a positive role for East Asian countries to realize the leap of industries to the high end of GVC by optimizing regional trade network relationships. Wenyi et al. (2023), on the other hand, argue that RCEP's network centrality and trade intensity has a significant positive impact on member states’ position of the GVC division of labor, especially developed countries.

Social network analysis focuses on the study of direct and indirect connections between members of a social network, a way of quantifying social relations from a structuralist perspective, a relational perspective that has been widely used in many fields of social sciences, including political science, sociology, and psychology (Manuel 2021). The advantage of the social network analysis is that it is not just a one-way causal analysis, but a more comprehensive two-way interaction analysis, which can accurately quantify the group network environment, the individual characteristics in the group network environment, and so on. Therefore, social network analysis has begun to be gradually applied in the field of economics, and the scope encompasses both the macro level in terms of world trade patterns and the micro level in terms of the activities of transnational corporations (Chen,2011; Rebeca et al., 2022). In the context of an increasingly complex global trade environment, social network analysis can effectively

complement value-added trade accounting.

It can be seen that a great deal of existing research has been conducted on value chain resilience, and regional trade networks. This article proposes to achieve the following breakthroughs based on the existing literature:(1) Although the existing literature has quantitatively analyzed value chain resilience from both micro and macro perspectives, due to industry heterogeneity and the fact that the service industry is an important source of intermediate goods, this article will take the service industry as the object of study to quantitatively analyze value chain resilience so as to clearly identify the feedback of the value chain to shocks from the mesoscopic level. (2) The existing literature has analyzed the impact of trade network relationships on the position of GVC. However, in the context of the impact of uncertainties on value chains and the accelerated fragmentation and restructuration of value chains, how to enhance the resilience of value chains is crucial. Therefore, this article focuses on the impact of trade network relationships on enhancing the resilience of industrial value chains to supplement the research perspective of the existing literature. (3) Scholars have already focused on regional trade network relationships under RTAs, but China's service industry should not only optimize trade network relationships under RTAs but also catalyze diversified trade relations to release more dividends. Therefore, on the basis of the "tripod" structure of RVC in North America, Europe, and East Asia delineated by JU Jiandong et al. (2020), this article, in conjunction with “the Belt the Road” Initiative, selects the three regional trade networks of North America, Europe and “the Belt the Road” as the research area, and utilizes the method of comparative analysis to condense the effect of differentiated regional trade network relationships on the value chain resilience.

3. Development status of regional trade network relationships

3.1 Indicator measures of network relationships

3.1.1 *Density*. Density is a measure of the closeness of relationships between nodes in a network. A higher density means that there is a close relationship between the participants in the network, and changes in the attitude and behavior of one actor in the network will be transmitted to other participants in the network through the dense network. The article uses the overall network density index to measure it.[1]

3.1.2 *Connectedness*. Connectedness describes the network environment from the perspective of stability. That is, if the increase in the density of a relational network is dependent on individual core nodes, then the other nodes in the network are more dependent on the core nodes, and the fluctuation of the core nodes will bring a huge shock on the network connectivity, and the structure of the network will face a great deal of instability. Meanwhile, the network's connectedness will be lower. On the contrary, if the number of independent pathways in the network, i.e., the connecting edges in the

[1] $D = \frac{m}{n(n-1)}$

In above formula, m is the actual number of relationships contained in the network and n is the number of actors.

network do not revolve around individual nodes, then the network has a strong degree of relevance. The higher the degree of connectedness, the more decentralized the network rights are, the more equal the participating subjects are, and the less susceptible they are to the influence of individual nodes. The article uses the network's relevance index to measure it.[2]

3.1.3 *Core-Periphery Analysis*. Core-periphery analysis is a method for specifying the structure of a network. Core nodes are subsystems with high innovative change and manipulation capabilities, while edge nodes are dependent on core nodes. Core and edge nodes together form a complete system of network relationships, in which core nodes dominate and determine the form of the network structure. The article applies Coreness to examine the core-periphery structure of network relationships. Meanwhile, referring to the research of Chen Yinfei (2011), countries with a Coreness greater than 0.1 are classified as core regions, countries with a Coreness of 0.01-0.1 are classified as semi-edge regions, and countries with a Coreness less than 0.01 are classified as edge regions.

3.1.4 *Cohesive Subgroup Analysis*. Cohesive subgroup analysis is a method of revealing the internal sub-structure of a network by taking the mutuality of the relationships between individual members as an entry node. Through cohesive subgroup analysis, it is possible to examine in-depth the cohesion of each subject in a network relationship and to clarify the potential patterns of relationships among actors in the context of the goals, norms, and cooperation of the cohesive group.

3.2 North American Regional Trade Network Relationships

Since 2007, the density of the North American regional trade network has shown a trapezoidal fluctuation, and there were obvious inflection nodes in 2011, 2014, and 2019 (the details are shown in Figure 1). There was a substantial increase in the density of the North American regional trade network relationship in 2011, from 0.583 to 0.667, and the reason for that was the gradual recovery of the economies of the countries after the U.S. subprime crisis in 2007, and the trade relationships between the countries became closer; density fell from 0.667 to 0.583 in 2014 owing to the trade disputes of the countries in the region and the impact of political factors; after the signing of the USMCA, trade between the United States, Mexico and Canada became closer so that the density rebounded to 0.667 in 2019.

The North American regional network connectedness remains perfectly correlated between 2007 and 2021, i.e., the network correlations are all 1 (e.g., Figure 1). The main reason for this is that the North

[2] $C = 1 - \left[\frac{V}{N(N-1)/2}\right]$

In above formula, V is the number of unreachable pairs of nodes in the network and N is the size of the network.

American regional trade network contains relatively few countries and maintains a stable trade in services between all countries during the years examined, resulting in a relatively high degree of stability. Under such connectedness, China, the United States, Mexico, and Canada are always the core countries in the whole trade network (Figure 2-a), and the strength of countries in the North American regional trade network is relatively balanced.

3.3 European Union Regional Trade Network Relationships

Both European Union (EU) regional trade density and connectedness have shown fluctuating upward trends since 2007, and both measures peaked in 2019, but COVID-19 has hampered trade associations between economies to some extent, resulting in a decline in density and connectedness in 2020 (Figure 1).

In terms of the structure of the trade network, the number of countries in the core and semi-edge regions of the EU regional trade network increases between 2007 and 2021 (Figure 2-c). In 2007, Germany, France, Spain, Italy, the Netherlands, Belgium, Luxembourg, Ireland, China, and Austria were in the core tier, while Poland and Portugal were in the semi-edge tier. Subsequently, there has been a continuous influx of countries into the core and semi-edge layers. Until 2021, based on the previous network structure, Slovakia, Greece, and Finland were in the semi-edge layer for the first time. It can be seen that not only the more stable developed countries have always been in the core of the trade network, but in recent years developing countries have also gradually entered the core regions, with the number of countries increasing from one to three. Meanwhile, the number of countries in the edge tier has been decreasing year by year, from 16 in 2007 to 8 in 2021.

In terms of the subregional structure of the trade network, the EU's regional trade network not only has the obvious characteristics of a "small world", but also consists of subgroups of developed countries with similar levels of economic development, and has a strong geographical proximity (as shown in Table 1). Germany and France were the most cohesive core countries in 2007, which led to the formation of six cohesive subgroups.

The number of cohesive subgroups decreased and then increased as a result of the fine-tuning of the subregional structure between 2011 and 2015 due to adjustments in the trade strategies of some countries. However, there is a structural change in the cohesive subgroups' structure in 2021, where not only did the number grow to eight, but also the Netherlands jumped up to become the third cohesive core country, on top of Germany and France. In addition, developing countries gradually entered the cohesive subgroup of developed countries, where the cohesive subgroup formed by China and EU

member states has accounted for almost half of the EU cohesive subgroups, i.e. China's cohesion in the EU's regional trade network has become stronger.

3.4 "The Belt the Road" Regional Trade Network Relationships

Although the density of trade networks in "the Belt the Road" region climbed from 0.011 in 2007 to 0.020 in 2021, the overall change was small (Figure 1). The same applied to connectedness, which rose from 0.022 in 2007 to 0.072 in 2021 (Figure 1). Although the stability of the trade network is gradually increasing, the indicator values show that the regional trade network of "the Belt the Road" is still mainly dependent on individual core countries, and when the trade of the core countries fluctuates, the entire network structure will face a huge shock. Therein, the countries at the core of the "the Belt the Road" regional trade network are mainly Singapore, South Korea, Malaysia, and China. With the further implementation of "the Belt the Road" Initiative, countries such as Russia, the Philippines, Cyprus, Italy, Luxembourg, and Vietnam have gradually moved from the edge to the core (as shown in Figure 2-b).

The development trend of cohesive subgroups shows that there was only one cohesive subgroup in "the Belt the Road" regional trade network between 2007 and 2015, namely the subregional trade network comprising China, South Korea, and Singapore (Table 1). By 2021, the number of cohesive subgroups increased to three, with China and Singapore as the core cohesive countries. The newly formed cohesive subgroups may be influenced by the signing and deepening implementation of RCEP. Moreover, China and Southeast Asian countries have certain advantages of geographical distance, and frequent exchanges and cooperation in various aspects, such as politics, culture, and economy, also contribute to the formation of subregional networks.

By comparing the forms of the three regional trade networks, it can be seen that the North American regional trade network, both in terms of density and connectedness, outperforms the other two regional trade networks and it has the closest associated countries and is highly stable. The EU regional trade network is the second. Although the advantages of "the Belt the Road" regional trade network are not obvious in terms of density and connectedness, China is a central node country in the core region of the network. Compared with North America and the EU regional trade network, China's dominant position in "the Belt the Road" regional trade network is more prominent and its cohesive capacity is superior.

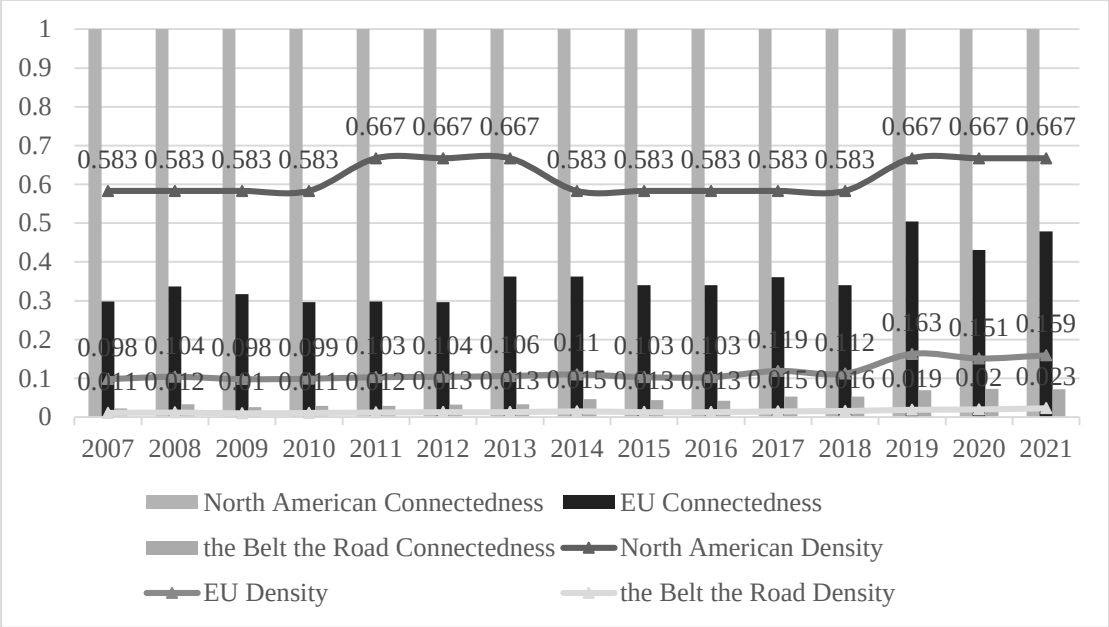

Figure 1 Density and Connectedness

Source: Calculated from data in the input-output tables of the Asian Development Bank database.

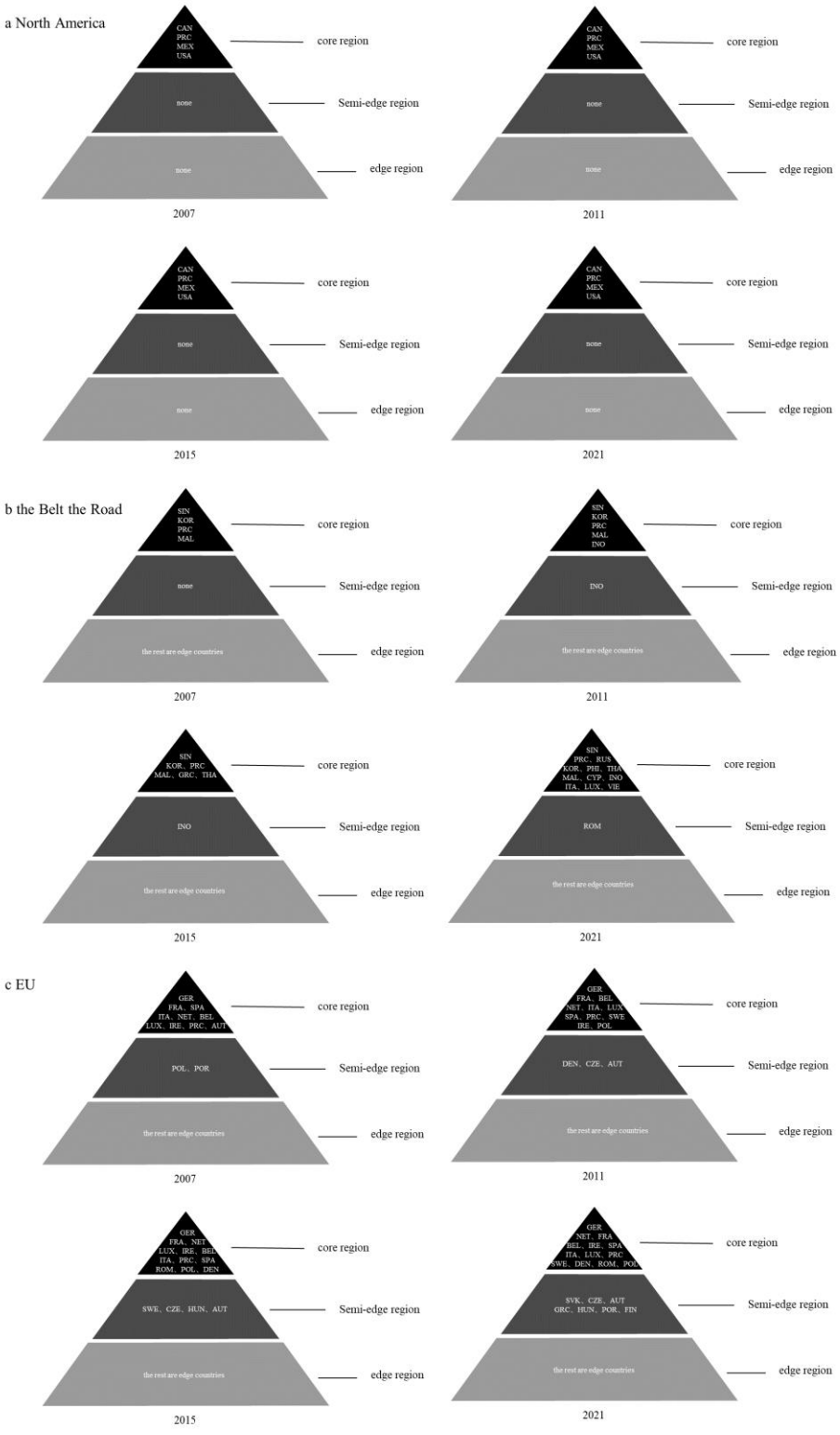

Figure 2 Core-Periphery Structure

Source: Calculated from data in the input-output tables of the Asian Development Bank database.

Table 1 Cohesive Subgroups

	subgroups	2007	2011	2015	2021
	1	PRC KOR SIN	PRC KOR SIN	PRC KOR SIN	PRC KOR SIN
	2				PRC MAL SIN

"the Belt the Road"	3				PRC THA SIN
EU	1	GER SPA FRA ITA NET	BEL PRC GER FRA NET	BEL PRC GER FRA NET	BEL GER FRA IRE ITA NET
	2	BEL GER SPA FRA NET	BEL GER FRA ITA LUX	BEL GER FRA ITA LUX	BEL GER FRA ITA LUX NET
	3	PRC GER FRA	GER SPA FRA ITA	GER SPA FRA	BEL GER SPA FRA LUX NET
	4	GER FRA ITA LUX	GER SPA FRA NET	GER FRA IRE ITA LUX	PRC GER DEN FRA NET
	5	BEL GER FRA LUX	GER IRE ITA LUX	GER FRA IRE NET	GER DEN FRA NET SWE
	6	GER IRE ITA NET		GER DEN SWE	PRC GER FRA ITA NET
	7				PRC GER SPA FRA NET
	8				GER FRA NET POL

Source: Calculated from data in the input-output tables of the Asian Development Bank database.

4. Overview of the development of China's service industry from the perspective of regional trade networks

4.1 Indicator measures of individual characteristics

Centrality is a quantitative analysis of an individual's power, which can clarify what kind of power an individual has or what kind of central position it occupies in the network. The article will quantify the individual characteristics of the Chinese service industry in the network in terms of degree centrality, betweenness centrality, and closeness centrality. Degree centrality measures the transactional ability of the actors themselves in the network. If an actor is directly connected to many nodes in the network, the actor has a higher degree centrality, a stronger trading capacity, and is more central and has more power in the international trade network. Betweenness centrality indicator measures an actor's "control ability", i.e. the extent to which an actor is positioned between two other actors. If a node is on a shortcut to many other pairs of nodes, it has a high degree of betweenness centrality, and the actor will be more likely to play an important "intermediary" role in the trade network, and thus be more possible at the center of the network. Closeness centrality indicator represents the extent to which an actor is not controlled by other actors. That is, the closer a node is to other nodes, the easier it is for that node to transmit information, the more likely it is to be at the center of the network, and the less dependent it is on others. A lower degree of closeness centrality means that the sum of the shortcut distances for an industry in a country to trade with other economies is smaller, i.e. the closer the trade "distance" is, the lower the trade costs are, the more reliable the trade information is, and the easier it is to establish a dominant position in the value chain.

4.2 Degree Centrality

In the North American regional trade network, the degree centrality of China's service industry has basically remained stable, ranking second with 0.667 (as shown in Table 2). Only when China and the United States faced a fierce trade conflict in 2018, as well as the North American region renewed the free

trade agreement(FTA), signed the USMCA to modify and improve the rules of trade in services, increased restrictions and protective measures for non-member states, suppressed the degree centrality of China's service industry in that year to a certain extent, down to 0.333. But in 2019, it quickly recovered to the previous level. China's service industry's degree centrality has a similar development trend in the EU and “the Belt the Road” regional trade network, both of which show fluctuating growth trends (as shown in Table 2). Herein, the fluctuation is more obvious in the EU regional trade network.

4.3 Betweenness Centrality

During the study period, the degree of betweenness centrality of China's service industry has a relatively low value in North America and the EU regional trade network. This indicates that in the above regional trade networks, the trading capacity of developed countries is significantly better than that of China, and the role of China's service industry as a "bridge" in these networks is exiguous. On the contrary, in “the Belt the Road” regional trade network, the betweenness centrality of China's service industry has obvious advantages, ranking first in 2019 and reaching a peak of 37.833 in 2021. China's service industry plays an important "intermediary" role in “the Belt the Road” regional trade network and is an important hub for other economies to trade in services.

4.4 Closeness Centrality

In the North American regional trade network, the closeness centrality of China's service industry is relatively stable, remaining at 0.833. In the EU regional trade network, the closeness centrality of China's service industry is on a downward trend. This indicates that the trade "distance" where China's service industry trades with EU economies is gradually decreasing. This is partly due to the China-Europe Railway Express, which has shortened the trade distance between China and the EU, creating a new pattern of international transport. On the contrary, China's service industry not only shows an increasing trend in closeness centrality in “the Belt the Road” regional trade network but also has a value over 100, much higher than the other two trade networks. On the one hand, this is due to the influence of infrastructure construction. On the other hand, in the context of the rapid development of the digital economy, the digital gap between China and the countries along “the Belt the Road” has also extended the "trade distance".

Table 2 China's Service Industry Centrality

	North America			EU			The Belt the Road		
Year	Degree	Betweenness	Closeness	Degree	Betweenness	Closeness	Degree	Betweenness	Closeness
2007	0.667（2）	0（2）	0.833（3）	0.148（6）	1（8）	88（7）	0.051(2)	-	109(2)
2008	0.667（2）	0（2）	0.833（3）	0.222（5）	1（10）	71（7）	0.051(2)	0.5(4)	167(2)
2009	0.667（2）	0（2）	0.833（3）	0.222（4）	1.083（9）	83（4）	0.051(2)	-	169(2)
2010	0.667（2）	0（2）	0.833（3）	0.185（5）	1.333（9）	73（6）	0.051(2)	7.5(3)	171(2)
2011	0.667（2）	0（2）	0.833（2）	0.222（4）	2（9）	83（9）	0.077(2)	8.5(3)	170(2)
2012	0.667（2）	0（2）	0.833（2）	0.259（4）	2（8）	69（4）	0.051(3)	1(3)	138(3)
2013	0.667（2）	0（2）	0.833（2）	0.259（3）	2.667（6）	69（3）	0.051(2)	1(3)	139(2)

2014	0.667（2）	0（2）	0.833（3）	0.222（4）	2（8）	82（5）	0.051(3)	1(3)	134(3)
2015	0.667（2）	0（2）	0.833（3）	0.222（4）	3.833（5）	71（5）	0.051(2)	8.5(3)	168(3)
2016	0.667（2）	0（2）	0.833（3）	0.222（4）	1.417（7）	71（5）	0.077(2)	1(3)	135(2)
2017	0.667（2）	0（2）	0.833（3）	0.222（6）	3.417（6）	70（6）	0.051(2)	1(3)	134(3)
2018	0.333（3）	0（2）	0.833（3）	0.185（6）	7.2（5）	86（6）	0.077(2)	6.667(3)	136(2)
2019	0.667（2）	0（2）	0.833（2）	0.259（7）	3.95（7）	74（7）	0.015(3)	35.25(1)	213(5)
2020	0.667（2）	0（2）	0.833（2）	0.259（5）	3.045（7）	67（5）	0.128(2)	31.5(2)	163(3)
2021	0.667（2）	0（2）	0.833（2）	0.222（10）	3.019（6）	75（7）	0.128(2)	37.833(2)	166(3)

Source: Calculated from data in the input-output tables of the Asian Development Bank database.

Note: Figures in () are rankings of the centrality of China's service industry, and "-" indicates missing data in the database.

5. Theoretical analysis of the impact of regional trade network relationships on value chain resilience

5.1 Spillover effects of degree centrality

Degree centrality reflects a country's ability to establish close trade relations with other economies in terms of trade breadth. A high degree centrality on the one hand increases a country's responsiveness to shocks and risks. A higher degree centrality means that a country expands its scope of trading partners, at which node the spread of uncertainty shocks will advance sequentially among trading partners, giving a country sufficient time to anticipate the effects of shocks and actively respond to them, thus improving the overall value chain resilience from the perspective of improving operational value chain resilience. On the other hand, since degree centrality reflects a country's ability to establish direct trade relations with other economies, therefore, when a country's industrial value chain encounters risky shocks, it can flexibly adjust its trade strategy through direct trade associations under a high degree centrality, and the effect of the change in trade strategy can be quickly realized. That is, a high level of degree centrality enhances the structural value chain resilience through positive response to risky shocks and rapid recovery, thus strengthening the overall industrial value chain resilience.

Hypothesis 1: Degree centrality is positively related to the resilience of China's service industry value chain.

5.2 Spillover effects of betweenness centrality

The higher the degree of betweenness centrality, the more accurate and timely the crucial country in the value chain will be in grasping the information on the direction of the shock, the strength of the shock, and the effect of the response to the shock, so that the country can shorten its response time to the shock, and even do sufficient early warning and response before the shock arrives. Meanwhile, a high degree of betweenness centrality means that core node countries can dominantly lead the value chain by coordinating upstream and downstream trade activities and allocating resource flows, thus achieving

active control over the negative impacts of shocks and enhancing the stability of the value chain. Finally, countries with a high degree of betweenness centrality have the ability to efficiently connect global and domestic value chains. The smooth flow of the dual circulation can accelerate the developmental process of domestic and foreign trade integration. It is conducive to the formation of a strong domestic market and at the same time helps foreign trade enterprises to improve their ability to resist risks.

Hypothesis 2: Betweenness centrality is positively related to the resilience of China's service industry value chain.

5.3 Spillover effects of closeness centrality

Countries that take advantage of closeness centrality, make use of convenient trade access to optimize their trade structure and are able to continue to promote in-depth participation in the international division of labor while at the same time reducing their trade dependence on individual economies, thus improving the value chain resilience in terms of stabilizing the trade structure. From the perspective of technological innovation, closeness centrality reduces trade costs by shortening trade "distance", and reserves funds for breaking through technological bottlenecks and achieving technological innovation. Technological innovation is the core element that enables industrial value chains to recover quickly from shocks, and low closeness centrality enhances the overall service value chain resilience by strengthening the technological value chain resilience. From the perspective of influence, low closeness centrality makes it easier for products to enter other countries' markets, and it establishes a good reputation among other economies through the diffusion effect of large volume and high quality, forming and strengthening the influence and competitiveness of independent brands, and the branding effect will, in turn, once again promote the occupancy rate and competitiveness of products in the international market, thus forming a virtuous circle. Under the guidance of consumer preference theory, the reduction of product substitution rate can fundamentally reduce or eliminate the negative effect of shocks on the value chain resilience.

Hypothesis 3: Closeness centrality is negatively related to the resilience of China's service industry value chain.

5.4 Stack effects of centrality and density

The above spillover effects of centrality on value chain resilience will further produce a scaling effect when superimposed density. On the one hand, network density has a scaling effect. If the trade relationship in the trade network is a virtuous interaction, the higher the density, the bigger the amplification effect. That is, if the countries in the trade network are each other's core trading partners, and the establishment of trade relations is centered on “win-win”, then when uncertainties hit the value chain, the countries will adjust their trade strategies from a global perspective, so that the negative impacts of the shocks will not only not be spread dramatically because of the high density, but will also be weakened rapidly because of the coordinated and unified countermeasures taken by the countries. Meanwhile, if the relationships between countries in the trade network are established with a long-term interest and have strong inclusiveness, the network of trade relations will be more resilient, the possibility of external shocks interrupting the trade relations will be sharply reduced, and the weakening of the volatility of the trade network relationship will make it possible for it to steadily and consistently transmit the positive spillover effects of the centrality of the network, which will feedback doubly and positively to the value chain resilience. Conversely, density will have a contractionary effect, weakening the

spillover of the positive effects of centrality on increasing value chain resilience.

6. Empirical Analysis

6.1 Econometric modeling and variable descriptions

In order to verify the hypotheses presented above, the following econometric model was constructed:

$$LnGVC\_PL_t=\alpha_0+\alpha_1 LnDE_t+\alpha_2 LnIN_t+\alpha_3 LnCL_t+\sum\alpha_4 LnCtrol_t+\varepsilon_t+d_t+I_t$$

In the model, t means time, and $LnGVC\_PL_t$ represents the value chain resilience of China's service industry in year t, which is logarithmic. $LnDE_t$, $LnIN_t$, and $LnCL_t$ respectively show the degree centrality, betweenness centrality, and closeness centrality of the Chinese service industry in year t after the logarithm transformation. $LnCtrol_t$ is the set of all control variables, done logarithmically, specifically including value added in the service industry, employment in the service industry with a bachelor's degree or higher, wages in the service industry, fixed asset investment and foreign investment in the service industry. ε_t is the random error term, d_t signifies Time Fixed Effects, I_t means Industry Fixed Effects.

Global value chain resilience has multiple dimensions. This article uses stability and security as entry nodes, indicating value chain resilience. This article refers to the article drawn by John et al. (2008) to measure the stability of value chains in terms of the magnitude of fluctuations in the length of the value chain.[3]

The security of the value chain is then measured by the gap in the length of the value chain with reference to Yang Renfa et al. (2023).[4]

Given that the indicators selected in this article all measure value chain resilience inversely, i.e., the larger the value of the indicator, the less resilient the value chain. Therefore, the hypotheses above are adjusted as follows:

Hypothesis 1: Degree centrality is negatively related to the resilience of China's service industry value chain.

Hypothesis 2: Betweenness centrality is negatively related to the resilience of China's service industry value chain.

Hypothesis 3: Closeness centrality is positively related to the resilience of China's service industry value chain.

The table below shows the selection of variables in the regression equation:

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[3] $pl_{ijt} = plv\_gvc_{ijt} - \overline{plv\_gvc_t}$, $Vol\_pl_{ijt} = [\frac{1}{T-1}\sum_{t=1}^{T}(pl_{ijT} - \frac{1}{T}\sum_{t=1}^{T} p\, l_{ijT})^2]^{1/2}$

In above formulas, plv_gvc_{ijt} is the GVC length of industry j in country i in year t, $\overline{plv\_gvc_t}$ is the average value chain length of all industries, which is defined as system risk, and pl_{ijt} is the GVC length of industry j in country i in year t after removing risk. T is the observation window of opportunity, and Vol_pl_{ijt} is used to measure the stability of the value chain of industry j of service industry in country i in year t, and the smaller the value of this indicator, the lower the volatility of the value chain and the greater its stability.

[4] $gap\_pl_{ijt} = \max(plv\_gvc_{jt}) - plv\_gvc_{ijt}$

In above formula, $\max(plv_gvc_{jt})$is the maximum value chain length for industry j in year t. $gap_pl_{ijt}$is the gap in GVC length for industry j in country i in year t, and the larger the value, the wider the gap between countries' GVC and the trading powers, the fewer the segments in which countries participate in GVC, and the less secure the GVC.

Table 3 Explanatory notes for the variables

Variable Codes	Variable Names	Unit	Data sources
GVC_PL	global value chain resilience	-	Asian Development Bank database
DE	degree	-	Asian Development Bank database
IN	betweenness	-	Asian Development Bank database
CL	closeness	-	Asian Development Bank database
Ctrol	added value	billions	National Bureau of Statistics of China
	employment with a bachelor's degree or higher	ten thousand	China Population & Employment Statistical Yearbook
	wages	billions	China Labor Statistical Yearbook
	fixed asset investment	%	China Statistical Yearbook of Tertiary Industry
	foreign investment	ten thousand dollars	National Bureau of Statistics of China

6.2 Analysis of empirical results

6.2.1 Benchmark regression results

The results of the benchmark model regression are shown in Table 4. (1) Benchmark regression model under the North American regional trade network, (2) Benchmark regression model under the European Union regional trade network, and (3) Benchmark regression model under “the Belt the Road” regional trade network. The regression results from the benchmark model show that the regression results for degree centrality, betweenness centrality, and closeness centrality are consistent with the hypotheses. Among the networks, the degree centrality of China's service industry has the greatest effect on enhancing the stability of its value chain in “the Belt the Road” regional trade network relationship, and for every 1 unit decrease in degree centrality of China's service industry, the stability of the value chain increases by 0.3384 units, which is mainly benefiting from the signing and further implementation of “the Belt the Road” Initiative and RCEP. FTAs established at a high level not only expand the development space for the improvement of the degree centrality of China's service industry, but also, the trade relations established under the guarantee of trade terms will surely contribute to a leap in the resilience of the value chain from the perspective of stability. Besides, from the perspective of value chain security, the degree centrality of China's service industry in the North American regional trade network has a significant and efficient effect on value chain security, with every 1 unit decrease in the degree centrality of China's service industry, the security of the value chain increases by 0.6808 units, and “the Belt the Road” region is the second, with a regression coefficient of 0.5086, which is mainly due to the Chinese service industry’s high-quality service trade relations release more positive spillover effects in the North American regional trade network constructed by developed economies. As a result, the development of the industry in the North American regional trade network will feed back more and more significantly into the value chain, and the balanced development of the economies in the value chain contributes to the level of security in the value chain. However, in “the Belt the Road” regional trade network, there is a big gap between the economic development levels of the economies in the value chain, and polarization is more serious, so the development of China's service industry has a very limited

effect on the overall value chain resilience.

In addition to degree centrality significantly contributing to value chain resilience, betweenness centrality has the same effect. Unlike degree centrality, an increase in the betweenness centrality of China's service industry has the most significant effect on the improvement of value chain stability in the EU regional trade network, which is mainly because of the relatively high degree of regional trade integration in the EU, and under this trade network, China's service industry can still be active in the EU region as a "top-down" intermediary, indicating that China's service industry has stronger control over the upstream and downstream production segments, and is at the core of the pivot position. Therefore, as a key node in the trade network, high-quality development of China's intermediary status would significantly improve the stability of the value chain. Additionally, the effect of the betweenness centrality indicator on value chain security has the greatest feedback in the North American regional trade network. The number of economies included in the North American regional trade network is relatively small, and acting as an intermediary between upstream and downstream has become the main form of integration. The ability of an industry to communicate and coordinate upstream and downstream determines the depth and quality of integration into the value chain. As a developing country in the North American regional trade network, China's service industry reinforces the impact of intermediation on the security of the value chain in the presence of a certain technological gap with developed economies.

The effect of closeness centrality on value chain resilience is only found in “the Belt the Road” regional trade network. On the one hand, this is due to the actual trade distance, which is relatively costly between China and North American countries compared to the trade distance between countries along “the Belt the Road”. Although this situation is relatively mitigated across EU countries and there are positive spillover effects from the China-Europe Railway Express, the cohesion of China's service industry in the EU regional trade network is relatively low, and there are fewer instances of subregional trade networks formed with China at their core. The main reason for China's service industry in the core region is its large trade in service with individual countries. However, China's service industry still has a long trade distance from the generalized economies in the EU regional trade network. On the other hand, it is due to the existence of a digital gap. With the deep integration of the digital economy and the real economy, the application of digital technology in trade in service is becoming more and more widespread. However, in North America and the EU regional trade networks, there is a huge data gap between China and developed countries, and the spillover effect of digital technology to enhance value chain resilience by shortening the "distance" of trade has still not been stimulated. On the contrary, in “the Belt the Road” regional trade network, most of the countries are developing and underdeveloped, and China's service industry is relatively advanced in the application of digital technology, therefore, the positive feedback of closeness centrality on value chain resilience is more evident in “the Belt the Road” regional trade network.

Table 4 Benchmark regression results

explanatory variables	stability			security		
	（1）	（2）	（3）	（1）	（2）	（3）
DE	-0.0903***	-0.2069**	-0.3384*	-0.6808***	-0.3939**	-0.5086*
	（0.1525）	（0.1000）	（0.1881）	（0.2196）	（0.1633）	（0.2661）
IN	-0.1765***	-0.1970***	-0.1693***	-0.1946***	-0.0292*	-0.0983***
	（0.0385）	（0.0298）	（0.0421）	（0.0575）	（0.0594）	（0.0662）
CL	0.2834	0.1245	0.6854**	0.2004	0.0809	0.1959**
	（0.2479）	（0.1371）	(0.2701)	（0.3298）	（0.2195）	(0.3747)

C	-6.95206*** (0.7725)	-6.2277** (0.7282)	-7.9840*** (0.9154)	-7.0716*** (1.4472)	-4.5016** (1.9290)	-5.9642*** (1.6939)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
control variables	Yes	Yes	Yes	Yes	Yes	Yes
sample size	120	120	120	120	120	120
R^2	0.7377	0.7527	0.7086	0.2387	0.1292	0.1492

Note: "***", "**", and "*" indicate 1%, 5%, and 10% significance levels respectively, and Heteroskedasticity-Robustity+Standard+Error within ().

6.2.2 Robustness Test

The robustness of the model is tested by replacing the core variables, i.e., replacing the explanatory variables with backward linkage-based indicators of the average GVC length of China's service industry. The backward linkage-based value chain length indicator measures the distance from the final consumer goods to the initial inputs, which continues to measure value chain resilience in terms of extensibility and the degree of embeddedness. The results are shown in Table 5, given that the value chain length indicator based on backward linkage is positively related to the value chain resilience, i.e., the larger the value of the value chain length based on backward linkage, the stronger the ability to extend the industrial value chain, the deeper the degree of embeddedness, and the better the security and stability of the value chain. Therefore, the hypotheses revert to the origin, i.e.:

Hypothesis 1: Degree centrality is positively related to the resilience of China's service industry value chain;

Hypothesis 2: Betweenness centrality is positively related to the resilience of China's service industry value chain;

Hypothesis 3: Closeness centrality is negatively related to the resilience of China's service industry value chain.

It can be observed that the regression results are the same as the regression results of the benchmark model, indicating that the model set up in the article is robust and reliable. Degree centrality and betweenness centrality still significantly and positively affect value chain resilience, i.e., the improvement of degree centrality and betweenness centrality of China's service industry will promote value chain resilience. Particularly, under "the Belt the Road" regional trade network, the reduction in the closeness centrality of China's service industry, i.e., the shortening of the trade distance between economies, will lead to an increase in the value chain resilience.

Table 5 Robustness test regression results

explanatory variables	（1）	（2）	（3）
DE	0.1659*** (0.0581)	0.0762* (0.0420)	0.1550** (0.1881)
IN	0.0356** (0.0152)	0.0000* (0.0153)	0.0455*** (0.0165)
CL	-0.1242 (0.0873)	-0.0215 (0.0565)	-0.1605* (0.0933)
C	1.3781***	1.0155**	1.3342***

	（0.3832）	（0.4967）	（0.4216）
Time Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
control variables	Yes	Yes	Yes
sample size	120	120	120
R^2	0.7328	0.7110	0.7361

Note: “***”, “**”, and “*” indicate 1%, 5%, and 10% significance levels respectively, and Heteroskedasticity-Robustity+Standard+Error within ().

6.2.3 Stacked effects regression results

In order to verify the existence of a certain scaling effect of centrality on value chain resilience under the transmission of social network relations, construct the following econometric model:

$$LnGVC\_PL_t=\beta_0+\beta_1 Ln(NET_t*DE_t)+\beta_2 Ln(NET_t*IN_t)+\beta_3 Ln(NET_t*CL_t)+\sum\beta_4 LnCtrol_t+\varepsilon_t+d_t+I_t$$

In the above model, NET denotes the regional relationship network attributes, which are respectively represented by density and connectedness.

The regression results for the stacked effects are shown in Table 6. First, the optimization of China's service industry centrality still contributes significantly to value chain stability through the transmission of trade relations. Second, owe to the small number of economies in North America, the transmission of positive spillovers from trade relations on industry centrality feeds back quickly and directly to value chain stability. Thus, the centrality of China's service industry in the North American regional trade network significantly enhances the stability of the value chain through the transmission of trade relations. Moreover, with the rapid development of China's service industry, the gap between trade in service and that of developed countries has gradually narrowed. In the North American regional trade network with a relatively balanced power, trade network relationships have more of an amplifying effect on centrality spillovers. What’s more, closeness centrality reinforces the impact of trade "distance" on the stability of the value chain over the stacked effect of trade network relationships. The establishment of direct and indirect trade associations not only directly enhances the stability of the value chain, but also, the complexity and equalization of trade network relationships will strengthen the trade exchanges among the economies in the region through multiple channels, and coupled with technological empowerment, the trade relations not only come from scratch, but also, with the shortening of the distance of the intermediate segments, the trade "distance" is further pulled forward. Therefore, under “the Belt the Road” regional trade network, the closeness centrality of China's service industry not only significantly affects the enhancement of the stability of the value chain, but also shows a significant positive impact in North America and the EU regional trade network. Finally, relatively balanced regional trade network relationships further catalyze the positive effects of centrality on value chain stability, and otherwise the opposite. There is a balance of power in the North American regional trade network. As a result, the optimization of the centrality of China's service industry has substantially increased the stability of the value chain through the transmission of trade network relationships. On the contrary, the EU and “the Belt the Road” regional trade network have not only failed to further strengthen the positive effect of centrality but also weakened their positive impact on value chain stability to a certain extent, due to the obvious “core-periphery” structure and the strong dependence of the development of trade network structure on the core node countries.

From the perspective of value chain security, although the centrality of China's service industry still maintains a positive relationship with value chain resilience, its effect on value chain resilience is

weakened by the transmission of trade network relationships, which is because the value chain security indicator focuses on measuring from the perspective of the gap between developed economies or large service countries. However, the transmission of trade network relationships not only fails to close the gap but also further amplifies the gap space as a transmission medium.

Moreover, whether it is value chain stability or value chain security, the stacked effect of trade relations under the North American regional trade network is extremely ineffective in catalyzing closeness centrality to act efficiently on value chain resilience. This is mainly because of the relatively high degree of construction of the North American regional trade network, and the optimization and upgrading of the service industry value chain has gradually escaped the influence of trade "distance". Therefore, even after adding the stacked effect of trade network relationships, the effect of China's service industry closeness centrality on value chain resilience is still not apparent.

Table 6 Stacked effects regression results

stability						
explanatory variables	Density			Connectedness		
	（1）	（2）	（3）	（1）	（2）	（3）
NET*DE	-0.1337***	-0.0269***	-0.0490***	-0.1634***	-0.1317***	-0.1903***
	（0.1641）	（0.1031）	（0.1950）	（0.1609）	（0.0953）	（0.1815）
NET*IN	-0.2061***	-0.1891***	-0.1399***	-0.2107***	-0.1713***	-0.0822*
	（0.0398）	（0.0342）	（0.0449）	（0.0392）	（0.0304）	（0.0458）
NET*CL	0.2886	0.2923**	0.2407*	0.4199*	0.5366***	0.4666**
	（0.2270）	（0.1150）	(0.2239)	(0.2184)	(0.1162)	(0.2022)
C	-5.6601***	-4.2085**	-5.1472***	-5.2130***	-3.4146***	-3.7102***
	（0.8074）	（0.7792）	（0.9145）	（0.8514）	（0.7935）	（0.8885）
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
control variables	Yes	Yes	Yes	Yes	Yes	Yes
sample size	120	120	120	120	120	120
R^2	0.7102	0.7445	0.6695	0.7100	0.7640	0.7019
security						
explanatory variables	Density			Connectedness		
	（1）	（2）	（3）	（1）	（2）	（3）
NET*DE	-0.4809**	-0.0374***	-0.3576***	-0.5274***	-0.3130**	-0.5258**
	（0.2023）	（0.1433）	（0.1881）	（0.1843）	（0.1551）	（0.2533）
NET*IN	-0.1914***	-0.0601*	-0.1072*	-0.1930***	-0.0003*	-0.1126*
	（0.0520）	（0.0593）	（0.0165）	（0.0479）	（0.0592）	（0.0658）
NET*CL	0.0666	0.5033***	0.1582***	0.2652	0.0389	0.4351***
	（0.2719）	（0.1659）	(0.2831)	(0.2502)	(0.1972)	(0.2854)
C	-8.5579***	-5.8751***	-7.3267***	-10.1979***	-7.0084***	-6.6033***
	（1.3424）	（2.0786）	（1.5492）	（1.2871）	（2.1492）	（1.7033）
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
control variables	Yes	Yes	Yes	Yes	Yes	Yes
sample size	120	120	120	120	120	120

R^2	0.3769	0.2355	0.2417	0.4708	0.1639	0.1693

Note: “***”, “**”, and “*” indicate 1%, 5%, and 10% significance levels respectively, and Heteroskedasticity-Robustity+Standard+Error within ().

7. Conclusions and countermeasures suggestions

7.1 Conclusions

The density of the three regional trade networks of North America, the EU, and “the Belt the Road” has been increasing year by year, although there still exists a certain “core-periphery” structure in the EU and “the Belt the Road” regional trade network. Although there is still a certain core-periphery structure in the EU and the "Belt and Road" regional trade network, and the power of each node country is seriously polarized, the development trend of equalization is accelerating, and the dependence on core node countries is weakening year by year. Additionally, the characteristics of subregional blocs within regional trade networks are becoming more prominent, and not only the number of cohesive subgroups is increasing, but also China's cohesion within them is growing, and the tendency to form regional trade subgroups with China as the core is becoming more and more prevalent. By further exploring the impact of industry centrality on value chain resilience, it is found that an increase in the degree centrality and betweenness centrality of China's service industry significantly strengthens value chain resilience, while the positive effect of closeness centrality on value chain resilience is only reflected in “the Belt the Road” regional trade network. Moreover, the construction of high-quality centrality in China's service industry will further strengthen the optimization effect on value chain resilience through balanced regional trade network relationships. On the contrary, the degree of polarization in trade network relationships will exacerbate the weakening motivation of centrality for value chain resilience.

7.2 Countermeasures Suggestions

In order to improve the resilience of China's service industry value chain by optimizing the regional trade network relationships based on RTAs, China's service industry should, on the one hand, continue to optimize its trade relations with developed economies, guiding and encouraging Chinese service industry enterprises to actively participate in the regional trade networks formed by developed countries, so as to cultivate their core competitiveness and narrow the gap with developed countries while fully enjoying the technology spillover effect. China's service industry needs to take the initiative to form influence, cohesion, and voice in high-level regional trade networks, dispersing the impact of uncertainties on the value chain. At the same time, it should actively cultivate the ability to stabilize the value chain and control the negative impacts on the value chain.

On the other hand, with “the Belt the Road" initiative, RCEP and other carriers, recoursing the signing of FTAs and the continuous deepening of development, China's service industry can further improve the trade "distance" between China's service industry and other economies in terms of lowering trade barriers and building a mutually beneficial and win-win trade environment, to intensify the closeness of China's service industry of the value chain, and to build high-quality trade platforms for shaping the resilience of the value chain. Meanwhile, the government should continue to promote the opening up of the system. As a core node country in “the Belt the Road” regional trade network, China's service industry should make full use of its core position to coordinate the trans-regional cooperation mechanism, and actively explore docking of international high-standard economic and trade rules, such as CPTPP, DEPA, etc. In this way, it can strengthen the diversified intra-regional trade associations, enhance the degree centrality

of China's service industry in the value chain, and create a stable trade environment for cultivating the value chain resilience from the perspective of strengthening the overall intensity of trade network relations. In addition, implementing policies to promote the cultivation of leading enterprises, and then strengthen the betweenness centrality of China's services industry in the value chain through leading enterprises, thereby properly guiding capital into medium and high technology industries, optimizing trade network relationships, making full use of the effects of technological spillovers and industrial transfers, activating research and innovation activities, and fostering core technological capabilities for optimizing the value chain resilience.

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References

[1] Ankrah D A, Agyei-Holmes A, Boakye A A. Ghana's rice value chain resilience in the context of COVID-19[J]. Social Sciences & Humanities Open, 2021, 4(1): 100210.

[2] Ambulkar S, Blackhurst J, Grawe S. Firm's resilience to supply chain disruptions: Scale development and empirical examination[J]. Journal of operations management, 2015, 33: 111-122.

[3] Antràs P, Chor D. Organizing the global value chain[J]. Econometrica, 2013, 81(6): 2127-2204.

[4] Barling D, Samoggia A, Olafsdottir G. Dynamics of Food Value Chains: Resilience, Fairness and Sustainability[J]. Agriculture, 2022, 12(5): 720.

[5] Chen Y F. Analysis on social network of world trade situation in 2000-2009[J]. J. Int. Trade, 2011, 11(347): 31-42.

[6] Changhong P, Bin L. The Economics of China’s Opening Up: Develo** an Economic Theory That Explains China’s Achievement[J]. Social Sciences in China, 2021, 42(1): 53-76.

[7] Coral C, Mithöfer D. The backbone of agrifood value chain resilience: Innovation in the Ecuadorian banana value chain from a historical perspective[J]. World Development Perspectives, 2023, 29: 100476.

[8] Fagiolo G, Reyes J, Schiavo S. World-trade web: Topological properties, dynamics, and evolution[J]. Physical Review E, 2009, 79(3): 036115.

[9] Gereffi G. Global value chains and development: Redefining the contours of 21st century capitalism[M]. Cambridge University Press, 2018.

[10] Hohenstein N O, Feisel E, Hartmann E, et al. Research on the phenomenon of supply chain resilience: a systematic review and paths for further investigation[J]. International journal of physical distribution & logistics management, 2015, 45(1/2): 90-117.

[11] Ju J D, Yu X D, Lu B, et al. Analysis of the“Tripod”Structure in the Global Value Chain Network [J]. China Journal of Economics,2020,7(4):1-20

[12] Levalle R R, Nof S Y. Resilience by teaming in supply network formation and re-configuration[J]. International Journal of Production Economics, 2015, 160: 80-93.

[13] Ma S Z, Ren W W, Wu G J. The characteristics of agricultural trade network and its effects on the global value chain division: A study based on social network analysis[J]. Manage. World, 2016, 270(3): 60-72.

[14] Qu S, Yang D. Manufacturing Localization, Technology Backfire, and Economic De-globalization[J]. China Economist, 2023, 18(1): 46-67.

[15] Ren Y W, Yang Y, Wang Y, et al. Evolution of the global semiconductor trade geography and its dependencies [J]. Acta Geographica Sinica,2023,78(2):371-385.

[16] Sun H P, Wei W. The Resilience and Operation Risk of China′s Embeddedness into the Global Value Chain Under the Background of the COVID-19 Pandemic [J]. Review of Economic Research,2020(6):91-98.

[17] Shen M H, Zhang Z Y. New Progress and Response Strategies in the Reconstruction of the East Asian Regional Value Chain [J]. Intertrade,2023(9):21-34.

[18] Tang C S, Veelenturf L P. The strategic role of logistics in the industry 4.0 era[J]. Transportation Research Part E: Logistics and Transportation Review, 2019, 129: 1-11.

[19] Wen Y, Wen S H. Impact of RCEP Trade Network Evolution on Member Countries'Global Value Chains Position [J]. Economist,2023(10):43-52.

[20] Yang R, Zheng Y. Research on the impact of digital economy development on the labor division evolution and resilience of global value chain[J]. The Journal of Quantitative & Technical Economics, 2023, 40(8): 69-89.

[21] Zhen Z, Fengbin W. Evolution of GVC System Resilience in Response to the Impact of Adverse Events——A Longitudinal Study Based on Embedded Multi-Cases [J]. China Industrial Economics,2022(10):174-192.

[22] Zhen Z, Fengbin W, Wei Y. RECONFIGURATION OF GLOBAL VALUE CHAIN IN RESPONSE TO THE IMPACT OF COVID-19 PANDEMIC: THE EMERGENCE OF A MORE RESILIENT BUSINESS ECOSYSTEM[J]. Economic Theory and Business Management, 2022, 42(7): 66.

[23] Zuo B, Wu G, Zhang C, et al. Research on the impacts of trade agreements on global trade flows:Based on complex network perspective [J]. World Regional Studies,2024,33(01):1-17.

[24] Zuo Z W, Jin Y P, Feng D L. The Structural Evolution and Influencing Factors of ICT Products Trade Dependent Networks [J]. Intertrade,2023(3):76-86.