An Evaluation to the Global Supply Chain Security Evidence from China's High-End Manufacturing Sector

***Lijing Shang [1,2], Saiful Aman[3], Abdulkhabir Rahmat[1]**

[1]Malaysia Institute of Transport, Universiti Teknologi MARA, Shah Alam, Malaysia

[2]Economics and Trade College, Hebei Finance University, Baoding, China

[3]School of Surveying Science and Natural Resources College of Built Environment, Universiti Teknologi MARA, Shah Alam, Malaysia

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.9010178

Received: 31 December 2024; Accepted: 07 January 2025; Published: 10 February 2025

ABSTRACT

The globalization of supply chain in manufacturing sector stems from the global division of labor. Despite significant focus on global supply chain security, there remains a deficiency of quantitative research in this area. This study develops an evaluation index method for global supply chain security, including external dependence and market concentration. The study utilizes the established index to assess the global supply chain security for China's high-end manufacturing sector. The dependence of China's high-end manufacturing sector on the international market originally increased and then decreased, with the fall becoming more significant. The high-end manufacturing sector in China demonstrates significant market concentration in both upstream and downstream activities. Furthermore, the eight economies with the most substantial import and export volumes retain a stable status. The global supply chain security coefficient of China's high-end manufacturing sector initially increased and then subsequently declined from 2007 to 2022. In 2022, the security coefficient increased by 4.57% relative to 2007; yet, it was still inferior to that of China's low-end manufacturing sector. There are considerable disparities among China's seven high-end manufacturing sectors. This study reveals a notable finding: the downstream dependence and market concentration in China's high-end manufacturing sector exceed those in the upstream.

Keywords: Supply Chain Security; Global Supply Chain; Upstream Dependence; Downstream Dependence; Market Concentration; Supply Chain Risk

INTRODUCTION

Global supply chain operations have grown significantly as a result of the reduction of trade barriers across nations and free trade agreements (Dong & Kouvelis, 2020). It has drastically changed the nature of international trade, altering the structure of industries and ushering in a new era of international rivalry (Gereffi & Lee, 2012). Global supply chain activities involve not only the import and export of finished products but also the import of additional parts and components for export, as well as the trading of intermediate products across global borders. Many international corporations leverage the locational benefits of developing countries, such as low labor cost, advantageous government policies, and tax disparities, outsourcing manufacturing operations to overseas nations like China and India. The global supply chain has facilitated a significant relocation of industrial activities from developed countries in the global north to developing countries in the global south. Leading corporations located in the most developed countries primarily dominate the supply network. The benefits that countries derive from the global supply chain are contingent upon the degree of engagement in the global economy and the specific function they fulfill within the global supply chain. Developed countries maintain a monopoly on the initial production of high-value items, such as research, development, and design. In contrast, developing nations focus on the mass production of low-value goods (Hopper et al., 2009; Siddiqui, 2013). The shift to manufacturing sectors from Western

countries has had a significant impact on the global economy and industrial structure. China's competitive advantage in labor cost has led global manufacturing firms, particularly those from developed countries, to invest in and establish factories there. As a result, China has progressively emerged as the hub of global manufacturing sector. Nevertheless, in recent years, the global supply chain has experienced increased risks and vulnerabilities due to factors such as the growth of protectionism, the resurgence of anti-globalization sentiments, trade tensions between China and the United States, escalating labor costs in China, and the impact of the COVID-19 pandemic. As a result, the supply chain has changed, becoming either shorter, more localized, or more diversified (Baldwin & Freeman, 2022). Global supply chains exhibit a high degree of intricacy and unpredictability (Asamoah et al., 2022), which often exposes them to the risk of disruption (Park et al., 2016). Supply chain interruptions can arise from either natural or human sources (Asamoah et al., 2020). Supply chain disruptions not only result in immediate economic losses but can also have a long-lasting effect on the supply chain for an extended period, potentially spanning months or even years (Torabi et al., 2015).

Manufacturing progress, particularly fluctuations in the workforce, intricately links to economic robustness (Kliesen & Tatom, 2013). A country's production progress directly correlates with the development of a high-end manufacturing sector, a crucial strategic concern. It can decrease costly imports, enhance exports, and generate employment opportunities (He & Fallah, 2011). Chinese companies will expand their imports into the international market when domestic production fails to meet the raw material requirements (Kaplinsky & Morris, 2016). Influenced by many factors, numerous countries have proactively pursued strategies to reduce their dependence on global supply chains. These strategies include downsizing the chain, disrupting the network, securing the chain, and disengaging from the chain.

The rising cost of China's production factors, as well as rapid scientific and technical innovation, are transforming China's role as a global supply chain manufacturing link. The 2020 pandemic accelerated foreign firms' production and supply bases outside of China. The US increased taxes on China's high-tech and high-value products, jeopardizing the high-end manufacturing supply chain. The "stuck neck" technological issue poses a significant practical challenge that China has to solve promptly (Yu et al., 2023). Studying the supply chain security of China's high-end industries is a crucial and urgent subject.

Scholars have taken the study on risks and evaluation of supply chain security and have obtained rich results. However, the current results still exhibit certain imperfections. Firstly, there is a shortage of quantitative research on global supply chain security. And then, the current body of research on supply chain security predominantly emphasizes upstream studies, with comparatively fewer findings from downstream research. Finally, the current research lacks quantitative research on China's manufacturing industry's supply chain security, particularly in high-end manufacturing sector.

This study adopts the network analysis to investigate the risks and builds evaluation indexes for global supply chain security. The developed metrics are employed to assess the global supply chain security of China's high-end manufacturing industry.

LITERATURE REVIEW

Global Supply Chain Risk

The continuity and security of a business's supply chain rely on its capacity to effectively respond to and overcome disturbances. To ensure uninterrupted operations, it is necessary to establish a supply chain that is more resilient in minimizing the consequences of unexpected incidents (Kumar & Anbanandam, 2020). Supply chain resilience refers to the ability of an enterprise to quickly resume normal production after a disruption. Trent and Monczka (2002) highlighted the importance of global integration in procurement, emphasizing the need for collaboration across countries and companies. This entails fostering cross-national and cross-cultural cooperation to effectively address and mitigate the risks associated with supply chain disruptions. Such cooperation should involve both domestic and foreign suppliers and customers. Supplier and customer diversification, together with the geographical dispersion of supply nodes, are crucial elements of supply chain resilience. The concentration of the supply chain directly influences the extent to which a company depends on suppliers and purchasers to ensure its business's smooth operation.

In the upstream part of the supply chain, choosing fewer suppliers can reduce negotiation time and efforts to coordinate the supply base, reducing production delays. Nevertheless, relying on a limited number of suppliers or consumers results in increased vulnerabilities and uncertainty in terms of potential disruptions to the supply chain (Wang et al., 2021). If each supplier provides different inputs, when one of them fails to provide inputs, other suppliers cannot provide the same inputs, and the supply chain will not be able to maintain continuity (Miroudot, 2020). To strengthen the supply chain security, suppliers should have a certain degree of redundancy, or supplier diversification, to ensure that in the event of a supply failure, they can obtain the required inputs from other suppliers (Kamalahmadi & Parast, 2016). Supplier diversification involves expanding the sources of product supply chains by collaborating with multiple suppliers in various countries. This strategy aids in reducing the risk of supply chain disruptions and speeds up the recovery process. Additionally, establishing long-term relationships with suppliers can expedite the recovery process (Dubey et al., 2019; Jain et al., 2017). Diversifying suppliers and reducing supplier concentration can mitigate reliance on a sole or limited number of providers, particularly in volatile or turbulent conditions. Caselli et al. (2021) put forward the same point that focusing on a specific area within the global supply chain tends to heighten susceptibility to industry disruptions. However, they also found that diversifying suppliers and purchasers across borders tended to mitigate this sensitivity.

Similarly, customer concentration downstream of the supply chain indicates the proportion of revenue contributed by each customer (Saboo et al., 2017). Customer concentration offers the possibility of strengthening the bargaining power of major clients. Thus, organizations that have a larger proportion of their customer base concentrated on a few clients may require a greater amount of cash and increased flexibility to effectively respond to shifting market demands (Huang et al., 2016). Leung and Sun (2021) conducted a study on COVID-19, revealing that increased customer concentration negatively impacts a company's profitability and sales growth when faced with disruptions arising from political uncertainty.

Evaluation to Supply Chain Security

Whipple et al. (2009) reviewed supply chain security research and found that only two of the 21 articles had a quantitative component. These two quantitative studies empirically evaluate supply chain security from two perspectives. The first study discussed risk management systems using secondary data, while the second study evaluated how companies' investments in supply chain security affect company performance. Mahmoudi et al. (2022) discovered that they constructed a fuzzy ordinal priority approach for enterprises, based on the framework of elastic supply chain management, by collecting enterprise data.

Academics explore the database adopted in the global supply chain. Different countries or regions may produce and process products in a global supply chain. GDP is total output minus consumption of intermediate products. It measures the added value that goods and services create during production. Merchandise trade statistics document trade flows, encompassing all consumed intermediate products, potentially distorting current economic trends. Therefore, many indicators avoid global GDP and focus on trade value added. The increase in intermediate product trade flows and structural changes in supply chains pose a challenge to traditional trade statistics methods. Baldwin (2012) noted that the global supply chain uses the input of intermediate products in the input-output matrix as a measurement object. The World Input-Output Table (WIOT) contains the relationship and information between the input and output of intermediate products in various regions and has become the object of analysis for macro measurement of the global supply chain (Antràs & Chor, 2022). The cross-regional input-output table has become an essential tool.

However, in the existing literature, there is a lack of quantitative research on supply chain security and even less research on how to use input-output tables to evaluate global supply chain security.

Supply Chain Security of China's High-end Manufacturing Industry

Murphy and Willmott (2015) stated that the foundation of neoliberalism lies in the principles of free market capitalism and the fallacy of equal contractual relations. Low-wage economies generate costs, while developed countries in the global north disproportionately capture profits, exacerbating the inequality between economies in the global north and south (Free & Hecimovic, 2021). China's manufacturing sector has experienced rapid integration into the global value chain system because of its cost. As a result, multinational businesses are increasingly inclined

to establish factories in China, leading to a significant increase in production and trade within the industry (Gampfer & Geishecker, 2019). China has emerged as the primary driver for economic expansion in Asia (Hong et al., 2006). Economic globalization has led China to establish extensive manufacturing clusters that connect to global buyers and key component suppliers in East Asia, thereby facilitating the global distribution of Chinese products (Gereffi, 2009). Nevertheless, China fails to fully capture the majority of the value generated by its exports within its value chain. Developing countries have a significant external dependence due to the expensive research and development expenditures and intricate production procedures associated with high-tech sectors (Chen et al., 2022). Gaulier et al. (2005) pointed out that China's high-tech industry has the highest degree of external dependence; however, there are significant variations across different sectors. Grimes and Sun (2014) discovered a decrease in the percentage of high-end technological products imported by China from 2000 to 2012. The diversification of imports of intermediate items has resulted in lower pricing for services and intermediate products, as well as an enhancement of product quality. Goldberg et al. (2008) and Halpern et al. (2015) put forward the same view: import diversification has played a positive role in the quality of Chinese products.

This study aims to enhance the current body of literature in two aspects. First, the research develops assessment indicators for global supply chain security that integrate external reliance and market concentration from a supply chain perspective. Second, the study employs the built index to assess the global supply chain security of China's high-end manufacturing sector.

RESEARCH METHODOLOGY

Analysis of Global Supply Chain Risk

Let's use the supply chain upstream as an example for analyzing the security of the global supply chain, along with Fig1.The letter stands for country, and the arrow represents the direction of intermediate trade. Taking the upstream as an example, we look into the potential risks of the global supply chain in a country.

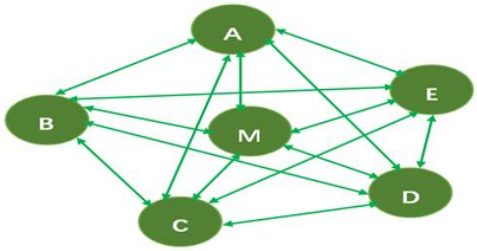

Fig.1 Global Supply Chain Risk

Country M imports intermediate items from economies A, B, C, D, and E. Simultaneously, the five economies engage in the exchange of intermediate goods between themselves.

First case, country M's domestic production is insufficient and intermediate goods rely heavily on imports from the international market. Country M faces a significant challenge when economies A, B, C, D, and E simultaneously decrease or stop supplying intermediate items to it. Most unfortunately, country M cannot develop alternative substitutes, resulting in a disruption of its production. If country M exhibits a low reliance on foreign intermediate items and possesses a robust capacity to generate alternative options, then the likelihood of experiencing disruptions in the supply chain is minimal. A country with a robust capacity to manufacture alternative products to those it imports will minimize the likelihood of supply chain disruptions and achieve a high level of supply chain resilience.

Second case, country M relies heavily on economies A for the import of intermediate products. If economies A decreases or terminates the export of intermediate goods to country M for certain reasons, and country M is unable to acquire the supply of intermediate goods from any of the other four countries in a certain timeframe, then the supply chain of country M is at risk of being disrupted. If country M can obtain the required intermediate goods from the other four economies while reducing imports from economies A, country M will maintain the stability of its supply chain. The higher the concentration of a country's intermediate product imports in the international market, the greater the supply chain risk.

The downstream of the supply chain refers to the export of the final product, and its security depends on the export dependence and export concentration of intermediate products internationally. The principle is the same to the security analysis of the upstream of the supply chain.

Evaluation Indicators for Global Supply Chain Security

Supply chain risks arise from upstream imports and downstream exports.

The dependence on global intermediate goods and market concentration influences upstream supply chain risk. Upstream dependence is the measure of the extent to which a given industry in a country (area) relies on intermediate products from another country (region) in its manufacturing process. A higher rate indicates greater reliance on the resources or services provided by the country or area upstream. The study employs CR_8 to evaluate upstream concentration in the supply chain. Market concentration is an indicator of the relative size of sellers or buyers in a particular industry or market. We use it to measure the number and relative size differences of enterprises, serving as an important quantitative indicator of market power. A widely used metric for estimating market concentration is the Concentration Ratio (CR_n), typically configured at 4 or 8. When CR_n is greater, it indicates lower competition and a higher monopoly. This study employs CR_8, a metric that quantifies the aggregate market shares of the eight largest economies concerning the intermediates imported by a specific industry. A higher CR_8 indicates a concentration of intermediate imports in a specific industry among a limited number of countries or regions, while a lower CR_8 indicates a greater diversification in the sources of imported intermediates. Upstream supply chain risk results from the interplay of upstream dependence and market concentration.

Market concentration and downstream dependence on international markets are the factors that determine downstream supply chain risk. A specific industry in one country or region exports a certain share of its fished products to another country or region, a measure known as downstream dependence. The bigger the share, the more dependent the nation is on its downstream region. The downstream concentration indicator, using CR_8, quantifies the aggregate market shares of the eight major economies based on the products exported by a specific industry. A higher CR_8 indicates a concentration of the industry's exports in a limited number of countries or areas, while a lower CR_8 indicates greater export diversification. Downstream supply chain risk results from downstream dependence and market concentration.

Supply chain risk is the combined effect of risks that occur in the upstream and downstream stages of the supply chain. Increased supply chain risk correlates with diminished security; conversely, higher safety corresponds with lower risk. This study uses a specific method to transform the risk coefficient into the security coefficient, defined as one minus the risk coefficient.

The relationship between the indicators is shown in Figure 2.

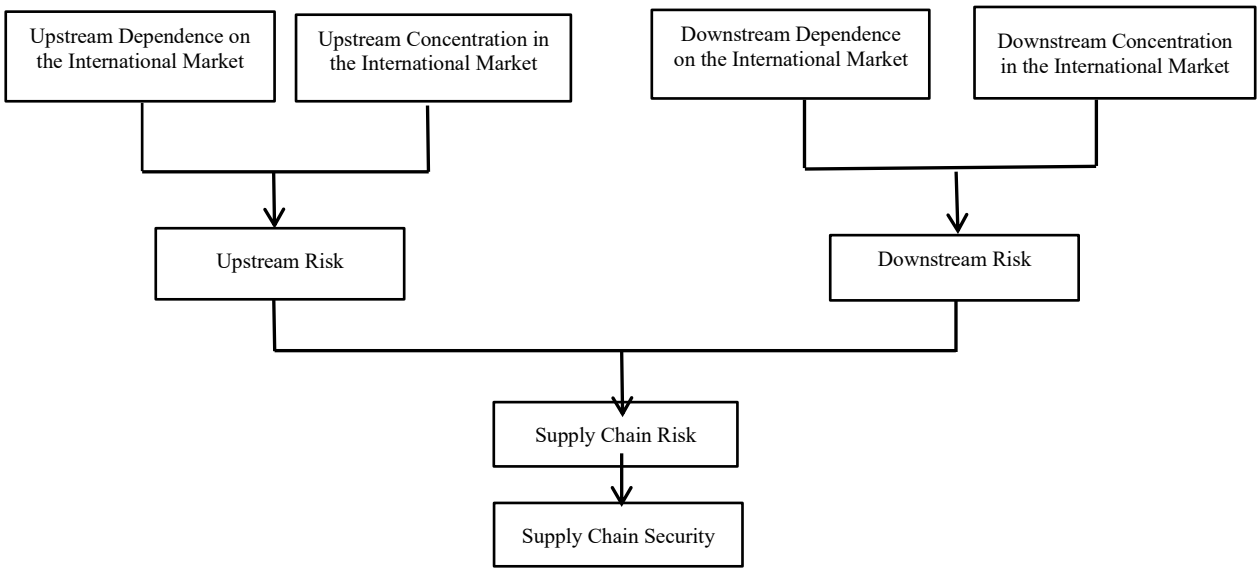

Fig.2 Evaluation Indicators System for Global Supply Chain Security

In this study, SR denotes the supply chain risk, SR_U signifies the upstream-dependent risk coefficient, and SR_D indicates the downstream dependent risk coefficient. UD refers to the upstream supply chain's dependence on international markets, while DD refers to the downstream supply chain's dependence on international markets. Upstream risk coefficient is represented by SR_U, and the formula is as follows:

$$SR_U = UD * CR_8^U \quad (1)$$

Downstream risk coefficient is represented by SR_D, and the formula is as follows:

$$SR_D = DD * CR_8^D \quad (2)$$

The supply chain risk formula of an industry is: the supply chain risk coefficient formula of an industry is:

$$SR = SR_U + SR_D \quad (3)$$

Supply chain security coefficient is constructed as follows:

$$SS = 1 - SR \quad (4)$$

The SS value ranges from 0 to 1. A higher SCS value indicates a lower supply chain risk and a greater level of safety.

Formulas for Evaluation Indicators

The formulas for upstream dependence, downstream dependence, and market concentration are listed below.

$$UD_i = \frac{\Sigma_{j=1}^{n} X_{ji}}{\Sigma_{j=1}^{n} X_{ji} + X_{pi}} \quad (5)$$

In the formula (5):

UD_i represents the upstream dependence on the international market of industry i in a region.

X_{ji} is the value of intermediate products imported by industry i of a region from country (region) j.

$\Sigma_{j=1}^{n} X_{ji}$ means the total value of intermediate goods imported by industry i of a region from the international market

X_{pi} denotes the worth of intermediate products supplied to industry i by the domestic sectors.

$$DD_i = \frac{\Sigma_{j=1}^{n} X_{ij}}{\Sigma_{j=1}^{n} X_{ij} + X_{ip}} \quad (6)$$

In the formula (6):

DD_i denotes the downstream dependence on the international market of industry i in a region.

X_{ij} represents the value of intermediate products exported by industry i in a region to country (region) j.

$\Sigma_{j=1}^{n} X_{ij}$ refers to the sum of the value of intermediate goods exported to the international market by industry i in a region.

X_{ip} is the value of intermediate goods that industry i of a region input into domestic production.

The Concentration Ratio (CR_n) assesses the aggregate market share of the largest n firms within an industry, evaluated by output, volume, sales, and other pertinent metrics. The value of n is usually set to 4 or 8

$$CR_n = \frac{\sum_{i=1}^{n} X_i}{\sum_{i=1}^{N} X_i} \quad (7)$$

In formula (7), Xi denotes the value of output, sales volume, or other relevant factors for the firm i in the industry. The total number of companies in the industry is denoted by N, whereas n is the count of the largest enterprises. This research adopts CR_8.

Table1 Symbol, Formula and Data for Evaluation Indicators

Index	Symbol	Formula	Data
upstream dependence on the International Market	UD	$\frac{\sum_{j=1}^{n} X_{ji}}{\sum_{j=1}^{n} X_{ji} + X_{pi}}$	volume of domestic input for intermediate goods，imports from economies in the international market
upstream concentration in the International Market	CR^{U}_{8}	$\frac{\sum_{i=1}^{n} X_i}{\sum_{i=1}^{N} X_i}$	imports from economies in the international market
downstream dependence on the International Market	DD	$\frac{\sum_{j=1}^{n} X_{ij}}{\sum_{j=1}^{n} X_{ij} + X_{ip}}$	domestic sale volume of products and export volume of products to economies in international market
downstream concentration in the International Market	CR^{D}_{8}	$\frac{\sum_{i=1}^{n} X_i}{\sum_{i=1}^{N} X_i}$	export volume of products to economies in international market

Data Source

The data on the intermediate products utilized in this study are derived from the Multi-Regional Input-Output Table (ADB-MRIO) published by the Asian Development Bank from 2007 to 2022. The Multi-Regional Input-Output Table includes 71 economies and incorporates the remaining economies to form the 72nd economy. The figures listed in the input-output table have been updated to 2022.The national economy is divided into 35 sectors in the Multi-Regional Input-Output Table represented by the letters C_1 to C_{35}. Out of the total sectors, 16 are part of the manufacturing industry, which is further categorized into 9 low-end manufacturing industries and 7 high-end manufacturing industries. This paper focuses on studying seven high-end manufacturing sectors, which are listed in Table 2.

Table 2 High-end Manufacturing Sectors

Code	Sector
C_8	Coke, refined petroleum, and nuclear fuel
C_9	Chemicals and chemical products
C_{11}	Other nonmetallic minerals
C_{12}	Basic metals and fabricated metal
C_{13}	Machinery, nec
C_{14}	Electrical and optical equipment
C_{15}	Transport equipment

RESULTS

Upstream Risks in the Supply Chain of China's High-end Manufacturing Sector

The upstream dependence on the international market of China's high-end manufacturing industry is calculated

using the data from the Multi-Regional Input-Output Table according to Formula 5, and the results are displayed in the second and fourth columns of Table 2. The upstream market concentration of China's high-end manufacturing industry on the international market from 2007 to 2022 is calculated based on formula 7, and the results can be found in the third and seventh columns of Table 3. According to Formula 1, the risk coefficient of the upstream supply chain is calculated, and the results are shown in the fourth and eighth columns of Table 3.

As shown in Table 3, China's high-end manufacturing industry had a fluctuating trend of upstream dependence on the international market, initially decreasing and then increasing. Between 2007 and 2016, China's high-end manufacturing industry became less reliant on the international market, with its dependence decreasing from 0.144 to 0.0742, a decline of 48.48%. However, it subsequently started to recover, with its dependence growing from 0.0809 in 2017 to 0.1135 in 2022, an increase of 40.30%.

From 2007 to 2022, the upstream concentration of China's high-end manufacturing industry in the international market remained elevated, exhibiting a pattern of initial increase followed by a decline. Except in 2012 and 2013, the upstream concentration of China's high-end manufacturing industry in the international market exceeds 0.4, reaching a peak of 0.4804 in 2019.

Table 3 Upstream Dependence, Market Concentration, and Upstream Risk Coefficient of China's High-end Manufacturing Sector Industry from 2007 to 2022

Year	UD	CR_8	SS_U	Year	UD	CR_8	SS_U
2007	0.1440	0.4696	0.0676	2015	0.0778	0.4002	0.0311
2008	0.1318	0.4656	0.0614	2016	0.0742	0.4664	0.0346
2009	0.1035	0.4633	0.0480	2017	0.0809	0.4676	0.0378
2010	0.1167	0.4237	0.0494	2018	0.0986	0.4389	0.0433
2011	0.1152	0.4008	0.0462	2019	0.1163	0.4804	0.0559
2012	0.1065	0.3678	0.0392	2020	0.1105	0.4745	0.0524
2013	0.1010	0.3695	0.0373	2021	0.1240	0.4378	0.0543
2014	0.0897	0.4060	0.0364	2022	0.1135	0.4299	0.0488

Note: UD denotes upstream dependence; CR_8 signifies market concentration; SS_U indicates upstream risk coefficient.

Table 4 lists the eight economies in which China's high-end manufacturing upstream is most dependent on the international market. The eight economies are arranged in descending order based on their import magnitude from China. As shown in Table 4, seven of them demonstrated a considerable level of stability between 2007 and 2022, ranking including KOR, TAP, JPN, AUS, GER, USA, and RUS. The remaining economy, which is not stable, occupies the final position in the rankings.

Table 4 Eight Economies in Which China's High-end Manufacturing Industry Upstream Relies Most on the International Market from 2007 to 2022

Year	CR_8	8 Economies
2007	0.4696	TAP, JPN, KOR, GER, USA, AUS, IND, RUS
2008	0.4656	JPN, KOR, TAP, AUS, GER, USA, RUS, IND

2009	0.4633	JPN, KOR, TAP, AUS, GER, USA, RUS, BRA
2010	0.4237	JPN, KOR, TAP, AUS, GER, USA, RUS, BRA
2011	0.4008	KOR, JPN, TAP, AUS, GER, RUS, USA, BRA
2012	0.3678	KOR, TAP, JPN, AUS, GER, RUS, USA, BRA
2013	0.3695	KOR, TAP, AUS, JPN, GER, USA, RUS, SIN
2014	0.4060	KOR, TAP, JPN, AUS, GER, USA, RUS, SIN
2015	0.4002	KOR, TAP, JPN, AUS, GER, USA, RUS, SIN
2016	0.4664	KOR, TAP, JPN, AUS, GER, USA, RUS, VIE
2017	0.4676	KOR, TAP, JPN, AUS, GER, USA, RUS, VIE
2018	0.4389	KOR, TAP, JPN, USA, AUS, GER, RUS, BRA
2019	0.4804	KOR, USA, TAP, JPN, AUS, BRA, GER, RUS
2020	0.4745	JPN, KOR, AUS, TAP, USA, GER, RUS, BRA
2021	0.4378	JPN, KOR, TAP, USA, AUS, RUS, GER, BRA
2022	0.4299	JPN, AUS, KOR, USA, TAP, RUS, GER, BRA

Downstream Risks in in the Supply Chain of China's High-end Manufacturing Sector

Table 5 displays the calculated downstream dependence and concentration of China's high-end manufacturing industry on the international market from 2007 to 2022. Formula 6 estimates the downstream risk coefficient, and the fourth and eighth columns display the results.

Table 5 indicates that, from 2007 to 2022, the downstream dependence of China's high-end manufacturing industry on the international market showed irregular changes with a noticeable overall decline. It dropped from 0.1972 in 2007 to 0.1084 in 2016, a decrease of 45.03%, and then began to rebound to 0.1474 in 2022. The downstream dependence of China's high-end manufacturing industry on the international market declined from 0.4673 in 2007 to 0.4233 in 2013, a reduction of 9.42%; it began to rise in 2014 to 0.4664 in 2022, close to the level in 2007.

The downstream concentration of China's high-end manufacturing sector in the international market exhibited a declining trend between 2007 and 2022, followed by resurgence. From 2007 to 2013, the downstream concentration of China's high-end manufacturing sector decreased from 0.4673 in 2007 to 0.4233 in 2013, subsequently rebounding to 0.4764 in 2022, surpassing the 2007 level.

Table 5 Downstream Dependence, Market Concentration, and Downstream Risk Coefficient of China’s High-end Manufacturing Industry from 2007 to 2022

Year	DD	CR_8	SS_D	Year	DD	CR_8	SS_D
2007	0.1972	0.4673	0.0922	2015	0.1195	0.4296	0.0513
2008	0.1818	0.4526	0.0823	2016	0.1084	0.4397	0.0477
2009	0.1392	0.4424	0.0616	2017	0.1164	0.4545	0.0529

2010	0.1515	0.4396	0.0666	2018	0.1135	0.4446	0.0505
2011	0.1426	0.4413	0.0629	2019	0.1417	0.4823	0.0683
2012	0.1341	0.4286	0.0575	2020	0.1423	0.4479	0.0637
2013	0.1269	0.4233	0.0537	2021	0.1481	0.4339	0.0643
2014	0.1281	0.4424	0.0567	2022	0.1474	0.4764	0.0702

Note: DD denotes downstream dependence; CR_8 signifies market concentration; SS_D indicates downstream risk coefficient.

In Table 6, we get and arrange the data on the top eight economies that have the highest exports of China's high-end manufacturing final products.

As shown in Table 6, between 2007 and 2022, six out of the eight economies, namely the USA, JPN, KOR, GER, TAP, and IND, have demonstrated stability, while the remaining two economies have relatively low rankings and are considered unstable. Following the inclusion of MEX and VIE in 2018, the eight economies have achieved a state of relative stability.

Table 6 Eight Economies in Which China's High-end Manufacturing Industry Downstream Relies most on the International Market from 2007 to 2022

Year	CR_8	8 Economies
2007	0.4673	USA, JPN, GER, KOR, TAP, IND, UKG, FRA
2008	0.4526	USA, JPN, KOR, GER, UKG, TAP, FRA, IND
2009	0.4424	USA, JPN, KOR, GER, IND, FRA, TAP, AUS
2010	0.4396	USA, JPN, KOR, GER, IND, UKG, TAP, MEX
2011	0.4413	USA, JPN, KOR, GER, IND, AUS, UKG, TAP
2012	0.4286	USA, JPN, KOR, GER, IND, UKG, AUS, TAP
2013	0.4233	USA, JPN, KOR, GER, UKG, IND, TAP, BRA
2014	0.4424	USA, JPN, KOR, HKG, GER, TAP, IND, UKG
2015	0.4296	USA, JPN, KOR, GER, IND, TAP, UKG, NET
2016	0.4397	USA, JPN, KOR, GER, IND, TAP, MEX, UKG
2017	0.4545	USA, JPN, KOR, GER, IND, MEX, TAP, NET
2018	0.4446	USA, JPN, GER, KOR, MEX, IND, VIE, AUS
2019	0.4823	USA, JPN, KOR, GER, MEX, VIE, TAP, IND
2020	0.4479	USA, JPN, GER, KOR, VIE, TAP, MEX, IND
2021	0.4339	USA, GER, JPN, KOR, VIE, MEX, TAP, IND
2022	0.4764	USA, JPN, KOR, GER, TAP, MEX, VIE, IND

Supply Chain Security Coefficient of China's High-end Manufacturing Industry

The supply chain security coefficients of China's high-end manufacturing industry are evaluated; the results are given in the second and fifth columns of Table 7. The supply chain security coefficients of China's low-end manufacturing are calculated, and the results are located in the third and sixth columns of Table 7. We compare the safety coefficients of the two manufacturing sectors.

Table 7 indicates that the supply chain security coefficient of China's high-end manufacturing industry increased from 0.8402 in 2007 to 0.9177 in 2016, an increase of 9.22%; then it decreased from 0.9177 in 2016 to 0.881 in 2022, but it was higher than 0.8402 in 2007.

Table 7 Supply Chain Security Coefficients for China's High-end and Low-end Manufacturing Industries

Year	High-end manufacturing	Low-end manufacturing	Year	High-end manufacturing	Low-end manufacturing
2007	0.8402	0.9017	2015	0.9175	0.9542
2008	0.8563	0.9152	2016	0.9177	0.9588
2009	0.8905	0.9304	2017	0.9093	0.9548
2010	0.8840	0.9287	2018	0.9063	0.9521
2011	0.8909	0.9338	2019	0.8758	0.9436
2012	0.9034	0.9408	2020	0.8838	0.9441
2013	0.9090	0.9456	2021	0.8815	0.9451
2014	0.9069	0.9484	2022	0.8810	0.9438

Figure 3 is developed based on Table 7. The supply chain security coefficient of China's high-end manufacturing sector is lower than that of the low-end manufacturing industry. From 2007 to 2022, the supply chain security coefficient of China's low-end manufacturing industry was above 0.9, while the supply chain security coefficient of the high-end manufacturing industry was below 0.9, but the gap between the two diminished until 2014, after which it expanded.

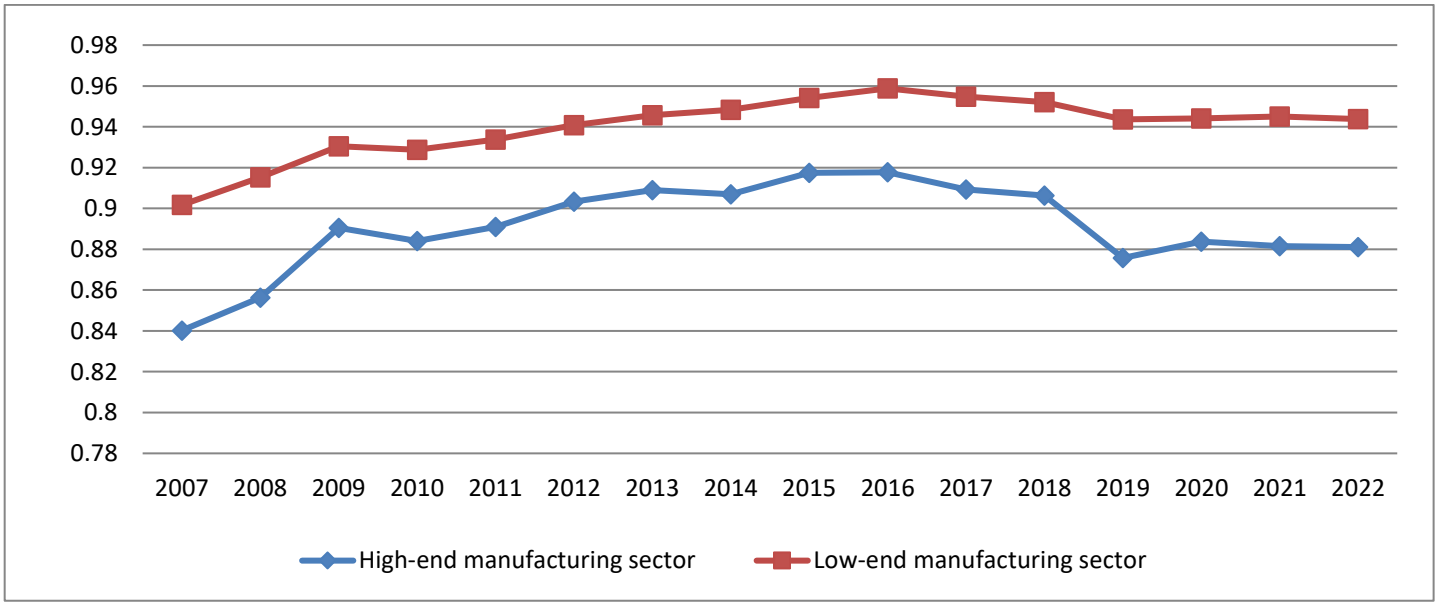

Fig.3 Supply Chain Security Coefficients for China's High-end and Low-end Manufacturing Industries

Supply Chain Security Coefficients of China's Seven High-end Manufacturing Sectors

We use the same method to obtain upstream dependence, market concentration, and upstream risk coefficient of China's seven high-end manufacturing industries in the international market from 2007 to 2022. Table 8 displays the results.

Table 8 Upstream Dependence, Market Concentration, and Upstream Risk Coefficient of China's Seven High-end Manufacturing Industries in the International Market from 2007 to 2022

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
C_8	UD	0.2041	0.2224	0.1797	0.2108	0.2197	0.2097	0.1943	0.1705	0.1478	0.1412	0.1541	0.1856	0.3125	0.3013	0.3385	0.3125
	CR_8	0.3686	0.3676	0.3916	0.4055	0.4138	0.3714	0.3314	0.3044	0.2657	0.3126	0.3791	0.3881	0.4133	0.4311	0.3984	0.5147
	SS_U	0.0752	0.0818	0.0704	0.0855	0.0909	0.0779	0.0644	0.0519	0.0393	0.0441	0.0584	0.0720	0.1292	0.1299	0.1349	0.1608
C_9	UD	0.1212	0.1110	0.0886	0.0953	0.0919	0.0786	0.0723	0.0656	0.0569	0.0544	0.0592	0.0715	0.0817	0.0784	0.0880	0.0811
	CR_8	0.5202	0.5074	0.5125	0.5085	0.4864	0.4744	0.4681	0.4733	0.4663	0.5231	0.5060	0.4236	0.4758	0.4732	0.4367	0.4605
	SS_U	0.0630	0.0563	0.0454	0.0485	0.0447	0.0373	0.0338	0.0311	0.0265	0.0285	0.0300	0.0303	0.0389	0.0371	0.0384	0.0373
C_{11}	UD	0.0896	0.0961	0.0709	0.0851	0.0863	0.0763	0.0700	0.0633	0.0549	0.0524	0.0571	0.0691	0.0688	0.0656	0.0735	0.0676
	CR_8	0.3984	0.3740	0.3957	0.4025	0.3936	0.3689	0.3569	0.3515	0.3324	0.3800	0.3999	0.3992	0.4272	0.4323	0.3939	0.3881
	SS_U	0.0357	0.0359	0.0281	0.0343	0.0340	0.0281	0.0250	0.0222	0.0182	0.0199	0.0228	0.0276	0.0294	0.0284	0.0290	0.0262
C_{12}	UD	0.0991	0.1041	0.0888	0.1053	0.1118	0.1032	0.1037	0.0892	0.0773	0.0739	0.0805	0.0972	0.1108	0.1061	0.1190	0.1096
	CR_8	0.4173	0.3949	0.4037	0.3840	0.3348	0.2940	0.2805	0.2795	0.2608	0.3107	0.3202	0.3633	0.3851	0.4114	0.3787	0.3840
	SS_U	0.0414	0.0411	0.0359	0.0404	0.0374	0.0303	0.0291	0.0249	0.0202	0.0230	0.0258	0.0353	0.0427	0.0437	0.0451	0.0421
C_{13}	UD	0.1017	0.0909	0.0782	0.0877	0.0836	0.0767	0.0730	0.0639	0.0554	0.0529	0.0577	0.0697	0.0796	0.0763	0.0855	0.0788
	CR_8	0.5712	0.5895	0.5657	0.5449	0.4977	0.4795	0.4640	0.5159	0.5228	0.5538	0.5428	0.4800	0.5340	0.5224	0.4800	0.4335
	SS_U	0.0581	0.0536	0.0442	0.0478	0.0416	0.0368	0.0339	0.0330	0.0290	0.0293	0.0313	0.0335	0.0425	0.0399	0.0410	0.0342

C_{14}	UD	0.2442	0.2060	0.1615	0.1611	0.1472	0.1395	0.1356	0.1221	0.1059	0.1011	0.1102	0.1330	0.1553	0.1493	0.1676	0.1546
	CR_8	0.5334	0.5529	0.5440	0.5449	0.4388	0.4356	0.4706	0.5537	0.5632	0.6753	0.6808	0.5173	0.6275	0.5802	0.5542	0.4945
	SS_U	0.1303	0.1139	0.0879	0.0878	0.0646	0.0608	0.0638	0.0676	0.0596	0.0683	0.0750	0.0688	0.0974	0.0866	0.0929	0.0765
C_{15}	UD	0.0869	0.0742	0.0602	0.0619	0.0605	0.0555	0.0521	0.0478	0.0414	0.0396	0.0431	0.0520	0.0595	0.0572	0.0642	0.0592
	CR_8	0.6489	0.6749	0.6591	0.6357	0.6009	0.5704	0.5582	0.6225	0.6295	0.6502	0.6387	0.5793	0.6306	0.6316	0.5843	0.5835
	SS_U	0.0564	0.0501	0.0397	0.0394	0.0364	0.0317	0.0291	0.0298	0.0261	0.0257	0.0275	0.0301	0.0375	0.0361	0.0375	0.0345

Note: UD denotes upstream dependence; CR_8 signifies market concentration; SS_U indicates upstream risk coefficient.

The results of the downstream dependence, market concentration, and downstream risk coefficient of China's seven high-end manufacturing industries in the international market from 2007 to 2022 are listed in Table 9.

Table 9 Downstream Dependence, Market Concentration, and Downstream Risk Coefficient of China's Seven High-end Manufacturing Industries in the International Market from 2007 to 2022

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
C_8	DD	0.0286	0.0367	0.0444	0.0310	0.0322	0.0309	0.0329	0.0330	0.0309	0.0283	0.0309	0.0391	0.0527	0.0536	0.0558	0.0550
	CR_8	0.5285	0.6367	0.6006	0.3672	0.5964	0.6655	0.6315	0.5972	0.5892	0.6895	0.6546	0.7305	0.6905	0.6135	0.4580	0.4077
	SS_D	0.0151	0.0234	0.0267	0.0114	0.0192	0.0206	0.0208	0.0197	0.0182	0.0195	0.0202	0.0286	0.0364	0.0329	0.0256	0.0224
C_9	DD	0.1094	0.1049	0.0763	0.0903	0.0879	0.0732	0.0685	0.0709	0.0663	0.0609	0.0659	0.0655	0.0846	0.0861	0.0896	0.0883
	CR_8	0.5587	0.5600	0.5339	0.5336	0.5437	0.5264	0.5037	0.5231	0.5230	0.5499	0.5259	0.3615	0.4546	0.4412	0.4017	0.4765
	SS_D	0.0611	0.0587	0.0407	0.0482	0.0478	0.0385	0.0345	0.0371	0.0347	0.0335	0.0347	0.0237	0.0385	0.0380	0.0360	0.0421
C_{11}	DD	0.0535	0.0546	0.0395	0.0530	0.0523	0.0559	0.0545	0.0528	0.0494	0.0454	0.0491	0.0453	0.0483	0.0492	0.0512	0.0504
	CR_8	0.4867	0.5077	0.4795	0.4715	0.5219	0.4539	0.4275	0.4417	0.4345	0.4421	0.4545	0.5380	0.6118	0.4224	0.4624	0.4934
	SS_D	0.0260	0.0277	0.0189	0.0250	0.0273	0.0254	0.0233	0.0233	0.0215	0.0201	0.0223	0.0244	0.0295	0.0208	0.0237	0.0249

C_{12}	DD	0.0992	0.0952	0.0619	0.0738	0.0761	0.0707	0.0673	0.0703	0.0658	0.0604	0.0654	0.0604	0.0706	0.0718	0.0785	0.0773
	CR_8	0.5641	0.5584	0.5449	0.5534	0.5657	0.5320	0.4984	0.4721	0.4598	0.4862	0.4916	0.5519	0.5959	0.5020	0.4622	0.5314
	SS_D	0.0560	0.0532	0.0337	0.0408	0.0430	0.0376	0.0335	0.0332	0.0303	0.0294	0.0322	0.0333	0.0421	0.0360	0.0363	0.0411
C_{13}	DD	0.2092	0.2021	0.1420	0.1791	0.1795	0.1654	0.1578	0.1594	0.1492	0.1370	0.1482	0.1368	0.2262	0.2302	0.2395	0.2359
	CR_8	0.4680	0.4344	0.4289	0.4137	0.4268	0.4266	0.4056	0.4142	0.4030	0.4018	0.4183	0.4566	0.4244	0.4083	0.3631	0.4120
	SS_D	0.0979	0.0878	0.0609	0.0741	0.0766	0.0706	0.0640	0.0660	0.0601	0.0550	0.0620	0.0625	0.0960	0.0940	0.0870	0.0972
C_{14}	DD	0.4605	0.4163	0.3750	0.3459	0.3173	0.3080	0.2942	0.2962	0.2754	0.2490	0.2652	0.2302	0.3036	0.3089	0.3177	0.3130
	CR_8	0.4741	0.4632	0.4755	0.4667	0.4653	0.4591	0.4631	0.4884	0.4710	0.4833	0.5034	0.4866	0.5463	0.5140	0.4974	0.5448
	SS_D	0.2183	0.1928	0.1783	0.1614	0.1476	0.1414	0.1362	0.1447	0.1297	0.1203	0.1335	0.1120	0.1659	0.1588	0.1580	0.1705
C_{15}	DD	0.1292	0.1270	0.0823	0.0891	0.0895	0.0840	0.0724	0.0701	0.0656	0.0602	0.0652	0.0602	0.0806	0.0820	0.0853	0.0840
	CR_8	0.4437	0.4237	0.3180	0.3416	0.3311	0.3296	0.3525	0.3943	0.3685	0.3827	0.3990	0.4407	0.4310	0.4386	0.4898	0.4569
	SS_D	0.0573	0.0538	0.0262	0.0304	0.0296	0.0277	0.0255	0.0276	0.0242	0.0230	0.0260	0.0265	0.0347	0.0360	0.0418	0.0384

Note: DD denotes downstream dependence; CR_8 signifies market concentration; SS_D indicates downstream risk coefficient.

The supply chain security coefficients of China's seven high-end manufacturing sectors were calculated according to formula 4, and the results are shown in Table 10.

Table 10 reveals significant variations in the supply chain security coefficients among China's seven high-end manufacturing industries.

Table 10 Supply Chain Security Coefficients of China's Seven High-end Manufacturing Sectors from 2007 to 2022

Year	C_8	C_9	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}
2007	0.9097	0.8759	0.9383	0.9026	0.844	0.6514	0.8863
2008	0.8948	0.885	0.9364	0.9057	0.8586	0.6933	0.8961
2009	0.9029	0.9139	0.953	0.9304	0.8949	0.7338	0.9341

2010	0.9031	0.9033	0.9407	0.9188	0.8781	0.7508	0.9302
2011	0.8899	0.9075	0.9387	0.9196	0.8818	0.7878	0.934
2012	0.9015	0.9242	0.9465	0.9321	0.8926	0.7978	0.9406
2013	0.9148	0.9317	0.9517	0.9374	0.9021	0.800	0.9454
2014	0.9284	0.9318	0.9545	0.9419	0.901	0.7877	0.9426
2015	0.9425	0.9388	0.9603	0.9495	0.9109	0.8107	0.9497
2016	0.9364	0.938	0.96	0.9476	0.9157	0.8114	0.9513
2017	0.9214	0.9353	0.9549	0.942	0.9067	0.7915	0.9465
2018	0.8994	0.946	0.948	0.9314	0.904	0.8192	0.9434
2019	0.8344	0.9226	0.9411	0.9152	0.8615	0.7367	0.9278
2020	0.8372	0.9249	0.9508	0.9203	0.8661	0.7546	0.9279
2021	0.8395	0.9256	0.9473	0.9186	0.872	0.7491	0.9207
2022	0.8168	0.9206	0.9489	0.9168	0.8686	0.753	0.9271

Figure 4 is generated from Table 10. Figure 4 shows that the supply chain security coefficient of the C_8 decreases, whereas the coefficients of the other six sectors increase, although at varying rates. The disparity among the seven industries is rapidly narrowing. In 2007, the gap between C_{14} and C_{11} was 0.2869. In 2022, the gap narrowed to 0.1959, indicating a decrease of 31.72%. In 2007, the supply chain security coefficient of C_8 was second, following that of C_{11}. However, it had a significant decline from 2016 to 2019, particularly dropping from 0.9041 in 2018 to 0.8345, leaving it only above C_{14}. Before 2018, the supply chain safety factor of C_{13} was only slightly higher than that of C_{14}, but it was gradually increasing. However, in 2019, it experienced a significant decline from 0.9041 in 2018 to 0.8615, after this, it remained stable. The supply chain safety coefficients of C_9, C_{15}, and C_{12} are all at a high level, with little variation.

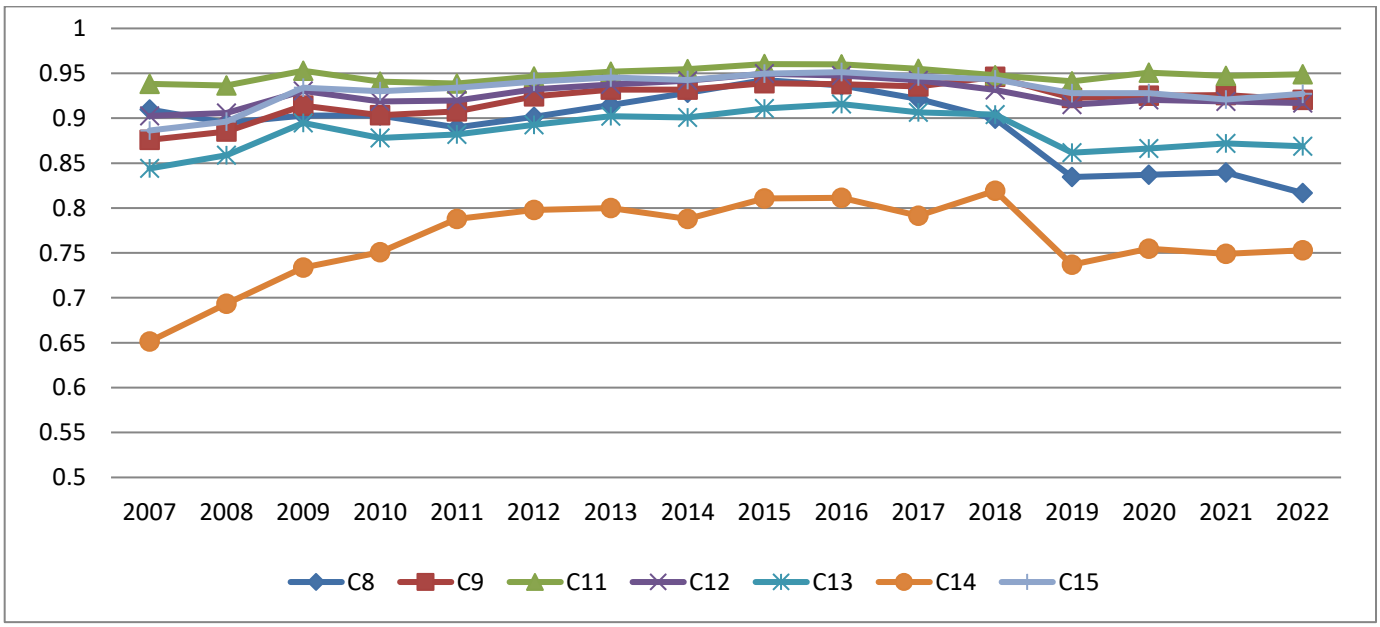

Fig.4 Supply Chain Security Coefficients of China's Seven High-end Manufacturing Sectors from 2007 to 2022

CONCLUSION AND RECOMMENDATIONS

This article develops an evaluation index for global supply chain security and applies it to the evaluation of China's high-end manufacturing sector. China's high-end manufacturing industry exhibits an initial decrease in external dependencies, followed by a subsequent expansion in both the upstream and downstream domains. The supply chain security coefficient of China's high-end manufacturing sector is rising; however, it is lower compared to China's low-end manufacturing. The supply chain safety coefficients of China's seven high-end manufacturing industries show significant differences. The security coefficients of some sectors are increasing, while those of others are decreasing. This paper also found that China's high-end manufacturing industry has a higher upstream dependence and market concentration than the downstream issues on the international market.

Based on the analysis results, the authors propose four suggestions. Firstly, maximize the advantages of China's huge domestic market. To improve the foreign investment climate, foster collaboration between local and foreign firms, enhance domestic supply and demand capacities, and decrease reliance on international markets for intermediate goods. Secondly, we need to prioritize the augmentation of technological research and development capacity. By increasing investment and engaging in collaborative efforts among multiple parties, we can effectively govern the fundamental technologies and products of the high-end manufacturing supply chain. This will reduce reliance on technologies and goods from certain countries and regions while also strengthening the supply chain's resilience. Also, keep moving forward with the "Belt and Road Initiative," improve cooperation across more regions, make the world's trade structure more efficient, increase the variety of intermediate goods imported and exported, lower reliance on a few economies like the US and Japan for high-end manufacturing, and make the supply chain more resilient. Implement a supply chain security monitoring system and prioritize industries with higher supply chain risks or significant declines in supply chain security. As an illustration, within the group of seven top-tier manufacturing sectors, C_{14} has the lowest level of supply chain security, while C_8 experiences a more significant decrease. Further investigation revealed that C_{14}'s low supply chain security factor is primarily due to its greater concentration in the upstream market and its increased reliance on the downstream sector. The significant rise in international reliance on upstream sources and market consolidation are key factors contributing to C_8's decrease in supply chain security. To address the issues and underlying factors affecting supply chain security in these two industries, it is essential to develop specific industrial policies that target and enhance the security levels of their supply chains.

REFERENCES

1. Antràs, P., & Chor, D. (2022). Global Value Chains. Contributions to Economics, 5, 297–376. https://doi.org/10.1007/978-3-031-20328-2_30
2. Asamoah, D., Agyei-Owusu, B., & Ashun, E. (2020). Social network relationship, supply chain resilience and customer-oriented performance of small and medium enterprises in a developing economy. Benchmarking, 27(5), 1793–1813. https://doi.org/10.1108/BIJ-08-2019-0374
3. Asamoah, D., Nuertey, D., Agyei-Owusu, B., & Acquah, I. N. (2022). Antecedents and outcomes of supply chain security practices: the role of organizational security culture and supply chain disruption occurrence. International Journal of Quality and Reliability Management, 39(4), 1059–1082. https://doi.org/10.1108/IJQRM-01-2021-0002
4. Baldwin, R. (2012). Global Supply Chains: Why They Emerged, Why They Matter, and Where. International Trade EJournal, 9103. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2153484
5. Baldwin, R., & Freeman, R. (2022). Risks and Global Supply Chains: What We Know and What We Need to Know. Annual Review of Economics, 14, 153–180. https://doi.org/10.1146/annurev-economics-051420-113737
6. Caselli, M., Fracasso, A., & Traverso, S. (2021). Globalization, robotization, and electoral outcomes: Evidence from spatial regressions for Italy. Journal of Regional Science, 61(1), 86–111. https://doi.org/10.1111/jors.12503
7. Chen, W., & Xing, L. (2022). Measuring the Intermediate Goods' External Dependency on the Global

Value Chain: A Case Study of China. Sustainability (Switzerland), 14(7). https://doi.org/10.3390/su14074360

8. Christopher, M., Lowson, R., & Peck, H. (2004). Creating agile supply chains in the fashion industry. International Journal of Retail & Distribution Management, 32(8), 367–376.
9. Dong, L., & Kouvelis, P. (2020). Manufacturing & Service Operations Management Impact of Tariffs on Global Supply Chain Network Configuration :Models, Predictions, and Future Research. Manufacturing & Service Operations Management, 22(1), 25–35.
10. Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., Blome, C., & Luo, Z. (2019). Antecedents of Resilient Supply Chains: An Empirical Study. IEEE Transactions on Engineering Management, 66(1), 8–19. https://doi.org/10.1109/TEM.2017.2723042
11. Free, C., & Hecimovic, A. (2021). Global supply chains after COVID-19: the end of the road for neoliberal globalisation? Accounting, Auditing and Accountability Journal, 34(1), 58–84. https://doi.org/10.1108/AAAJ-06-2020-4634
12. Gampfer, B., & Geishecker, I. (2019). Chinese competition: intra-industry and intra-firm adaptation. Review of World Economics, 155(2), 327–352. https://doi.org/10.1007/s10290-018-0337-1
13. Gaulier, G., Lemoine, F., & Ünal, D. (2007). China's Integration in East Asia: Production Sharing, FDI & High-Tech Trade. Economic Change and Restructuring, 27, 27–63.
14. Gereffi, G. (2009). Development models and industrial upgrading in China and Mexico. European Sociological Review, 25(1), 37–51. https://doi.org/10.1093/esr/jcn034
15. Gereffi, G. (2020). What does the COVID-19 pandemic teach us about global value chains? The case of medical supplies. Journal of International Business Policy, 3(3), 287–301. https://doi.org/10.1057/s42214-020-00062-w
16. Gereffi, G., & Lee, J. (2012). Why the World Suddenly Cares About Global Supply Chains. Journal of Supply Chain Management, 48(3), 24–32. https://doi.org/10.1111/j.1745-493X.2012.03271.x
17. GGoldberg, P. K., Khandelwal, A. K., Pavcnik, N., & Topalova, P. (2008). Imported Intermediate Inputs and Domestic Product Growth: Evidence from India. The Quarterly Journal of Economics, 125(4), 1727–1767. http://www.nber.org/papers/w14416
18. Grimes, S., & Sun, Y. (2014). Implications of China's on-going dependence on foreign technology. Geoforum, 54, 59–69.
19. Halpern, L., Koren, M., & Szeidl, A. (2015). Imported inputs and productivity. American Economic Review, 105(12), 3660–3703. https://doi.org/10.1257/aer.20150443
20. He, J., & Fallah, M. H. (2011). The typology of technology clusters and its evolution- Evidence from the hi-tech industries. Technological Forecasting and Social Change, 78(6), 945–952. https://doi.org/10.1016/j.techfore.2011.01.005
21. Hong, P., Noh, J., & Hwang, W. (2006). Global supply chain strategy: A Chinese market perspective. Journal of Enterprise Information Management, 19(3), 320–333. https://doi.org/10.1108/17410390610658496
22. Hopper, T., Tsamenyi, M., Uddin, S., & Wickramasinghe, D. (2009). Management accounting in less developed countries: What is known and needs knowing. Accounting, Auditing and Accountability Journal, 22(3), 469–514. https://doi.org/10.1108/09513570910945697
23. Huang, H. H., Lobo, G. J., Wang, C., & Xie, H. (2016). Customer concentration and corporate tax avoidance. Journal of Banking and Finance, 72, 184–200. https://doi.org/10.1016/j.jbankfin.2016.07.018
24. Jain, V., Kumar, S., Soni, U., & Chandra, C. (2017). Supply chain resilience: model development and empirical analysis. International Journal of Production Research, 55(22), 6779–6800. https://doi.org/10.1080/00207543.2017.1349947
25. Kamalahmadi, M., & Parast, M. M. (2016). A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. International Journal of Production Economics, 171, 116–133. https://doi.org/10.1016/j.ijpe.2015.10.023

26. Kaplinsky, R., & Morris, M. (2016). Chinese FDI in Sub-Saharan Africa: Engaging with large dragons. In The Power of the Chinese Dragon: Implications for African Development and Economic Growth.London: Palgrave Macmillan UK., 123–148. https://doi.org/10.1057/ejdr.2009.24
27. Kliesen, K. L., & Tatom, J. A. (2013). US manufacturing and the importance of international trade:It's not what you think. Federal Reserve Bank of St. Louis Review, 95(1), 27–49. https://doi.org/10.20955/r.95.27-50
28. Leung, W. S., & Sun, J. (2021). Policy Uncertainty and Customer Concentration. Production and Operations Management, 30(5), 1517–1542. https://doi.org/10.1111/poms.13335
29. Mahmoudi, A., Javed, S. A., & Mardani, A. (2022). Gresilient supplier selection through Fuzzy Ordinal Priority Approach: decision-making in post-COVID era. Operations Management Research, 15(1–2), 208–232. https://doi.org/10.1007/s12063-021-00178-z
30. Miroudot, S. (2020). Reshaping the policy debate on the implications of COVID-19 for global supply chains. Journal of International Business Policy, 3(4), 430. https://doi.org/10.1057/s42214-020-00074-6
31. Murphy, J., & Willmott, H. (2015). The rise of the 1%: An organizational explanation. In Research in the Sociology of Organizations (Vol. 43). https://doi.org/10.1108/S0733-558X20150000043013
32. Park, K., Min, H., & Min, S. (2016). Inter-relationship among risk taking propensity, supply chain security practices, and supply chain disruption occurrence. Journal of Purchasing and Supply Management, 22(2), 120–130. https://doi.org/10.1016/j.pursup.2015.12.001
33. Peleg-Gillai, B., Bhat, G., & Sept, L. (2006). Innovators in Supply Chain Security:Better Security Drives Business Value. Washington, DC: Manufacturing InstituteManufacturing Institute, 1–33.
34. Saboo, A. R., Kumar, V., & Anand, A. (2017). Assessing the impact of customer concentration on initial public offering and balance sheet-based outcomes. Journal of Marketing, 81(6), 42–61. https://doi.org/10.1509/jm.16.0457
35. Siddiqui, J. (2013). Mainstreaming biodiversity accounting: Potential implications for a developing economy. Accounting, Auditing and Accountability Journal, 26(5), 779–805. https://doi.org/10.1108/AAAJ-03-2013-1242
36. Sturgeon, T., Van Biesebroeck, J., & Gereffi, G. (2008). Value chains, networks and clusters: Reframing the global automotive industry. Journal of Economic Geography, 8(3), 297–321. https://doi.org/10.1093/jeg/lbn007
37. Todo, Y., Nakajima, K., & Matous, P. (2015). How do supply chain networks affect the resilience of firms to natural disasters? Evidence from the great east Japan Earthquake. Journal of Regional Science, 55(2), 209–229. https://doi.org/10.1111/jors.12119
38. Torabi, S. A., Baghersad, M., & Mansouri, S. A. (2015). Resilient supplier selection and order allocation under operational and disruption risks. Transportation Research Part E: Logistics and Transportation Review, 79, 22–48. https://doi.org/10.1016/j.tre.2015.03.005
39. Trent, R. J., & Monczka, R. M. (2002). Pursuing competitive advantage through integrated global sourcing. Academy of Management Executive, 16(2), 66–80. https://doi.org/10.5465/AME.2002.7173538
40. Voss, M. D., Whipple, J. M., & Closs, D. J. (2009). The role of strategic security: internal and external security measures with security performance implications. Transportation Journal, 48(2), 5–23. https://doi.org/10.5325/transportationj.48.2.0005
41. Wang, L., Liao, Y., Ding, Y., & Peng, T. (2021). The effect of customer concentration on supplier sustainable growth: evidence from China. Applied Economics, 53(17), 2015–2025. https://doi.org/10.1080/00036846.2020.1854670
42. Yu, R., Wang, Y., Zhao, Y., & Bai, W. (2023). Breakthrough Mechanism of "Stuck Neck" Technology: "Situation-strategy" Asymmetric Matching Perspective. Bulletin of Chinese Academy of Sciences (Chinese Version), 38(4), 580–592. https://doi.org/10.16418/j.issn.1000-3045.20221020003