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A COMPARATIVE STUDY OF MANUFACTURING GLOBAL VALUE CHAIN BETWEEN CHINA AND THE UNITED STATES

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Abstract: Both China and the United States are important participants and promoters of the Global Value Chain (GVC). In the context of the current Sino-US trade war, manufacturing, especially high-end manufacturing, is the focus of competition between China and the United States. By comparing and analyzing the division of labor and the evolution of the participation modes of the manufacturing industry in the GVC between China and the United States, it is helpful to clarify the comparative advantages of China and the United States, and the study of the performance evaluation results of the two countries, which is of great significance to China's construction of a self-dominated GVC. Based on the perspective of value-added trade, this study uses the latest value-added trade data of the OECD-TIVA database to estimate the position and participation mode of the manufacturing industry and its sub-industries in the two countries in the GVC division of labor, and through the study of performance evaluation results, the relationship between the two countries' GVCs is discussed. The results show that: (1) since 2005, the division of labor in the global value chain of China's manufacturing industry has been gradually improving, while the United States has been gradually declining. China's manufacturing industry is closely linked to the global value chain of China and the United States, forming a close relationship. (2) China's position in the global value chain of manufacturing industry is getting closer to that of the United States. China's total participation in manufacturing industry has been higher than that of the United States for a long time, and both countries' total participation in manufacturing industry has remained stable. (3) China's manufacturing industry is becoming less and less dependent on the US. On the contrary, the US is becoming more and more dependent on China. (4) From the grey correlation coefficient between different factors of China and the United States on the division of labor in the global value chain, GDP and R&D expenditure have the highest correlation, and exports of goods and services have a greater impact on the division of labor in the global value chain of the United States.

Keywords: Sino-US Manufacturing Industry; Global Value Chains; Division of Labor; The Embedded Mode; Performance Evaluation

1. INTRODUCTION

Since China's accession to the WTO, the trade volume between China and the United States has been on the rise, from us $80.485 billion in 2001 to us $630 billion in 2018. From 2000 to 2008, the trade volume between China and the United States has maintained double-digit growth. In terms of the proportion of total trade structure, China and the United States are each other's largest trading partners. The proportion of trade between China and the United States in China's total trade has always exceeded 12%, and the proportion of exports and imports has remained stable, reaching 18.99% and 8.36% respectively in 2017.In today's highly globalized world, trade between China and the United States has become inseparable. At the same time, with the evolution of the manufacturing structure, the GVC division of manufacturing process has become an important driving factor for the development of the world economy. Under this system of division of labor, enterprises in developed countries (such as the United States, Japan and Germany) transfer their processing and assembly lines to foreign countries and focus on technological innovation and product research and

development. Developing countries (such as China and Vietnam) manufacture, process, assemble and export the key parts needed by developed countries by virtue of the endowment advantage of basic factors of production (domestic labor force, land, factories, etc.).The United States and China are typical representatives of developed and developing countries, and their participation in the division of labor in GVC has led to the rapid development of their manufacturing industries. Judging from the development of manufacturing in China and the United States and the results of their respective performance evaluations, China has now become the largest manufacturer in the world. China has not only made important contributions to the domestic economic and social development, but also become an important force supporting the world economy. In 2010, the share of China's manufacturing industry increased to 18.39%, surpassing the United States for the first time as the world's largest manufacturing country. In 2017, China's manufacturing value-added share reached 26.56%. Compared with Japan, the growth rate of the manufacturing industry is much higher than that of the developed countries in Europe and the United States during the same period. The results of the performance evaluation show that China has maintained its position as the world's largest manufacturing country for eight consecutive years. The rapid development of the manufacturing industry has strengthened China's position in the GVC. In addition, the proportion of Sino-US manufacturing in the world has risen from 30.88% in 2004 to 43.39% in 2016. Therefore, maintaining long-term and stable cooperation between China and the US economy is essential for the healthy and stable development of the world economy. In the growing trade frictions between China and the United States, for overall manufacturing location in China and the United States, manufacturing mode, participation, and the dependence between the two countries and status in GVC index to measure, such as data decomposition analysis was carried out on the added value of bilateral trade, to correctly understand the status of the two countries in the global value chain and mutual relations, realize the complementary advantages, mutual benefit and win-win results, at the same time, it helps us to deepen the understanding of global value chain division theory and study its performance evaluation, which has important theoretical and practical significance.

In recent years, global value chains (GVCs) have been recognized and cited by many experts and scholars, and become the focus of many scholars' research. Such as Hummels, etc (2001)[1] to build a vertical specialization index, based on intermediates imports, exports and output to construct the vertical specialization index, reflect the vertical division of labor between countries, at the same time to measure a country (or region) contained in the export trade of the added value of abroad, and then realize the measure of a country (or region) to participate in the GVC degree of international division of labor. Daudin[2] used the Global Trade Analysis model (GTAP) to build a calculation formula to measure the added value of industries or countries, reflecting the value appreciation of final consumer goods or intermediate goods. Based on the multi-regional input-output (MRIO) model of the world, Koopman (2010)[3] decomposed a country's total exports into domestic value appreciation and foreign value appreciation, and constructed GVC status index and GVC participation index respectively, to reflect a country's status in the GVC division of labor and its participation degree in the GVC division of labor from the perspective of quality and quantity. Koopman (2010)[3] brought different countries into the same research framework and proposed the decomposition method of a country's total exports.

Many domestic scholars use the above index to analyze the international competitiveness of manufacturing industries in China and the United States. Yu Jue (2017)[4] used KPWW algorithm to calculate the dominant comparative advantage, intermediate dominant comparative advantage and embedded GVC in 19 sample manufacturing industries between China and the United States from 2000 to 2014, and concluded that China lags behind the United States in the position and participation degree of embedded GVC in most manufacturing industries. Li yuan and Kim Dianchen[5] used the GVC division of labor index proposed by Koopman et al.[3] to compare and analyze the international competitiveness of Chinese and American manufacturing industries. Wang LAN(2014) classified China's manufacturing industry according to its technical level, and used GVC status and participation index to measure the participation of China's manufacturing industry in GVC division of labor.

Regarding the research on the division of labor and the embedding mode of the GVC, early scholars mainly focused on the internal connections and external dependencies formed by the transnational economic community in the process of

embedding the GVC. Wang et al. (2009)[7] used the Asian International Input-Output Table (AIO) to examine the internal dependence of the East Asian region on value-added trade. Liu Zhongli and Zhao Ying (2014)[8] further studied the internal and external dependence of east Asia region from the perspective of "upstream dependence" and "final demand dependence", and found that the internal dependence of east Asia region was stronger than the external dependence on "upstream dependence", while the external dependence on "final demand dependence" of east Asia region was to some extent external dependence on Europe and America region. Li Genqiang and Pan Wenqing (2016)[9] used China's interregional input-output table to find that China's coastal and inland regions showed significant vertical and domestic specialization differences and value-added supply preferences in the process of embedding into the GVC. Ni Hongfu [10]and Xia Jiechang (2016) used the same data to analyze the rise in vertical specialization that originated from the increased differences in economic links between domestic and foreign countries and between coastal and inland regions. SuQingyi (2016)[11] used the interregional input-output table of 30 provinces in China to examine the value-added decomposition of Chinese provincial exports, and examined the relevant characteristics of domestic value chains on the basis of GVCs, but only for export without for provincial outflow of intermediate product or final product added value decomposition, and the interaction of domestic regional value chains is not further investigated. Shao Zhaodui et al. (2017) used Hummels et al. (2001)[1] 's method and considered processing trade and general trade issues, using the micro-level customs database to measure the degree of participation of Chinese provinces and regions in the GVC. Pan Wenqing et al. (2018) used the transnational input-output table containing different regions in China to analyze the added value of NVC and GVC participation in various regions in China from the perspective of value-added performance. Li Shantong et al. (2018)[12] expanded the WWZ decomposition method of trade added value by constructing an international input-output model that includes domestic inter-provincial input-output models, and proposed a unified framework for the decomposition of foreign trade (exports, inter-provincial transfers) in domestic provinces, and analyzed the status of different regions in China participating in GVCs and domestic value chains.

About performance evaluation, Liu Yanhua (2021)[13] deployed various management work of the enterprise based on the evaluation results by building a complete performance evaluation system; Liu Lei et al. (2021)[14] and the distribution of performance evaluation results in discipline attributes and project host characteristics; Zhang Tao et al (2021)[15] compare the travel behavior characteristics of low driving power population and the general public before and under the epidemic, define the evaluation indicators of travel security system for low driving power population, and build a performance evaluation model of travel security system for low driving power population based on matter-element analysis.

Through sorting out the above articles, we can find that with the deepening of economic globalization and the constant changes in the trade between China and the United States, the study on the trade between China and the United States has become more important. At the same time, most previous studies from the perspective of vertical specialization to measure the degree of one country or region to participate in GVC, mainly because the restricted by the GVC database availability, as well as the existing calculation methods can be difficult to achieve complete decomposition of the total amount of export trade, there are few involved prior to vertical specialization and its internal structure analysis, with the constant improvement of the database at the same time, the hope can make up for the previous scholars study due to incomplete data of the defect. Based on the above research, this paper makes a comparative analysis of the international competitiveness and division of labor of Chinese and American manufacturing industries by using the TIVA database jointly released by WTO and OECD and the GVC status index and GVC participation index proposed by Koopman (2010)[3].

2.RESEARCH METHODS AND DATA SOURCES

2.1 Research Methods

2.11 Value-added Trade Decomposition Method

Value-added trade is based on vertical specialization (Hummels, 2001)[1], but it relaxes the assumption that "all

imported intermediates are completely composed of foreign value added" in the calculation of vertical specialization index, so as to be closer to the reality of global value chain division of labor (Wang Lan, 2014)[6]. Combining the studies of Hummels (2001)[1] and Wang and Wei (2009), Koopman (2010)[3] formed a standard statistical analysis framework for added value of trade, and decomposed a country's export into:

$$\begin{aligned} EX_i &= DV_i + FV_i \\ &= VV_i + NV_i + RI_i + FV_i \\ &= V_i B_{ii} \sum_{s \neq i} Y_{is} + V_i B_{ii} \sum_{s \neq i} A_{is} X_{ss} + V_i B_{ii} \sum_{s \neq i} \sum_{t \neq i,s} A_{is} X_{st} + V_i B_{ii} \sum_{s \neq i} A_{is} X_{si} + FV_i \end{aligned} \quad (1)$$

Among them, EX_i means the total exports, V_i means direct value increment coefficient, B_{si} means Leontief inverse matrix of the matrix, shows Country i to increase 1 unit of work required to final demand Country s intermediates, A_{is} means Country s work required to produce 1 unit of output Country r intermediate inputs into the production, Y_{is} means Country s on final demand Country i; X_{sr} is the export from Country s to Country i. Thus, one country's total exports (EX_i) can be divided into domestic value added (DV) and foreign value added (FV). The domestic value added can be divided into three parts: direct export value added (VV), indirect export value added (NV) and domestic value added reflux (RI). The increase in direct exports consists of two parts: first, the domestic value added ($V_i B_{ii} \sum_{s \neq i} Y_{is}$) in the export of final products and services absorbed by the importer; second, the domestic value added ($V_{ii} B_{ii} \sum_{s \neq i} A_{is} X_{ss}$) in the intermediate products that the country exports to the importing country for the production of products in domestic demand; Domestic value added reflux (RI) may represent the domestic value added in the intermediate products that the country exports to the importer to produce the reflux product ($V_{ii} B_{ii} \sum_{s \neq i} A_{is} X_{si}$); Indirect export added value refers to the domestic value added contained in the intermediate goods that the country exports to the importing country for its production of products exported to the third country ($V_{ii} B_{ii} \sum_{s \neq i} \sum_{t \neq i,s} A_{is} X_{st}$). By calculating the relevant indicators, it focuses on the mode in which the Chinese and American manufacturing industries participate in GVC, to what extent they integrate into GVC, and to what position they occupy in GVC.

2.12 Use the Added Value of Trade to Measure the Status of Product GVC Upgrading from Another Perspective

From the perspective of added value of trade, Koopman (2010)[3] constructed two indicators, GVC Participation and GVC Position, to fully and truly reflect the changes and trends of GVC and regional value chains. This topic of typical developed countries mainly from Koopman status of global value chain division of labor (2010)[3] measurement, $\text{GVC\_Participation} = \frac{IV_{ir}}{E_{ir}} + \frac{FV_{ir}}{E_{ir}}$, and IV representatives Country r's intermediate goods trade, export i to other countries, FV on behalf of Country r's industry i that is contained in the final product of imported products' value. E representatives Country's industry i in terms of the added value of exports, $\text{IV}_{\text{ir}} / E_{ir}$ is the former to the participation to the vertical specialization ratio (ahead), is used to reflect the degree of one country in the middle of the product to the contribution of the foreign supply chain, $\text{FV}_{\text{ir}} / E_{ir}$ is the participation rate for the following (to the vertical

specialization ratio), is used to reflect a country's imports of intermediate goods to foreign dependence of the supply chain. $\mathrm{GVC\_Position} = \ln(1+\frac{IV_{ir}}{E_{ir}}) - \ln(1-\frac{FV_{ir}}{E_{ir}})$, the higher the value is, the higher the country is located in the upstream of GVC and the higher the division of labor status in GVC.

2.13 Measure the Interdependence between the Typical Developed Country and Other Countries

Traditional trade theory analyzes the interdependence of international division of labor based on the total trade data of bilateral trade, but in the context of global value chain, bilateral value-added trade truly reflects the interdependence of production and division of labor in the world. To this end, we refer to Zhang Huiqing (2018)[16] to design the forward dependence index:

$BiDVA_{cj}(= RDVA_{cj} / RDVA_{jc} = (DVA_{cj} / DVA_c) \div (DVA_{jc} / DVA_j))$ and backward dependence index $BiFVA_{cj}(= RFVA_{cj} / EFVA_{jc} = (FVA_{cj} / FVA_c) \div (FVA_{jc} / FVA_j))$ to measure the characteristics of the dependence between the typical developed countries and the major economies in the global value chain, and focus on the evolution of the bilateral relations between the typical developed countries and the major economies. Among them, subscript c represents a typical developed country, and j represents a partner country of trade added value. $\mathrm{RDVA_{cj}}$ is the proportion of the value added of exports from typical developed countries to Country j in the total value added of exports from typical developed countries, and measures the forward dependence of typical developed countries on Country j. $\mathrm{RDVA_{jc}}$ is the proportion of the domestic value added of Country j's exports to typical developed countries in the total value added of Country j's exports to typical developed countries, and measures the forward dependence of Country j on typical developed countries. If $\mathrm{BiDVA_{cj}}$ is greater than 1, it indicates that the forward dependence of a typical developed country on Country j is higher, and the value added export of a typical developed country is more dependent on the market of Country j; otherwise, it indicates that the value added export of Country j is more dependent on the market of a typical developed country. The meaning of backward dependence index is the same.

2.14 Grey Relational Analysis Method Is Used to Explore the Differences in Factors Affecting the Position of Labor Division In the Value Chain between China and the United States

Grey correlation analysis method is a multifactor statistical analysis method, it is based on the factors of sample data using the grey correlation degree to describe the strength of the relationship between factors, size, and the order, if the two factors of sample data reflects the changes of the situation (direction, size and speed, etc.), then the correlation between them; Conversely, the correlation degree is smaller. The specific steps are as follows:

1) From the original sample data, we can find the standard sequence A0 and the comparison sequence Ai. Standard sequence set A0 = (x01, x02... , x0j,... ,x0n) is the target value sequence we want to evaluate the performance. The comparison sequence Ai = (xi1, xi2... ,xij,... ,xin), where I = 1, 2... , m. Each of the sequences needs to be compared with the standard sequence for sequence correlation.

2) Initialize these data, and the formula is:

$$\frac{\max X_i - X_i}{max X_i - min X_i}$$

3) Calculate the grey relational distance Δ0ij, including Δ0ij is every compare sequence and the distance between the standard sequence values.

$$\Delta_{0ij} = \left| X_{0j}^* - X_{ij}^* \right|$$

4) Calculate the grey relational coefficient of γ_{0ij}, which distinguish coefficient "ζ"between 0 and 1, the default value is 0.5.

$$\gamma_{0ij} = \frac{\Delta_{min} + \zeta\Delta_{max}}{\Delta_{0ij} + \zeta\Delta_{max}}$$

5) Calculate the grey relational degree value of each comparison sequence Γ_{0i}.

$$\Gamma_{0i} = \frac{1}{n}\sum_{j=1}^{n}\gamma_{0ij}$$

6) The grey relational degree values of all comparison sequences are sorted into grey relational order.

2.2 Data Sources

All the indicators in this section are calculated using the TIVA statistics jointly released by WTO and OECD, and the time range is from 2005 to 2015. The data on the factors affecting the location of GVCS are all from the world bank's development indicators database. At the same time in order to further investigate the characteristics of the global value chain different industries, we reference WIOD database for industry classification method, and the OECD development rule of density in the database, manufacturing can be divided into low technology in the manufacturing, manufacturing, high technology manufacturing three categories, of different types in different development stages of manufacturing embedded GVC model for further analysis (See Table 1).

Table 1 Manufacturing Industry Classification Table

Industrial Category	Industry Code	Specific Industry
Low-tech Manufacturing	D10-18	food, drink and tobacco; textiles, clothing, leather and related products; wood and wood and cork products; paper products and printing
Middle-tech Manufacturing	D19-25	coke and refined petroleum products; chemicals and pharmaceutical products; rubber and plastic products; other non-metallic mineral products; base metals; metal products
High-tech Manufacturing	D26-30	computer, electronic and optical products; electrical equipment; mechanical equipment; transportation equipment

3.ANALYSIS AND DISCUSSION OF EMPIRICAL RESULTS

3.1 Comparative Analysis of the Division of Labor in the Global Value Chain Between China and the United States

Table 2 Position Table of Global Value Chain Division Between China and the United States

	Overall Manufacturing Sector		Low-tech Industry		Middle-tech Industry		High-tech Industry	
	U.S.	China	U.S.	China	U.S.	China	U.S.	China
2005	0.178	0.111	0.299	0.234	0.171	0.161	0.153	0.028
2006	0.163	0.118	0.286	0.238	0.151	0.170	0.143	0.037
2007	0.162	0.140	0.291	0.261	0.153	0.179	0.140	0.068
2008	0.149	0.164	0.288	0.267	0.123	0.180	0.135	0.113
2009	0.183	0.210	0.308	0.297	0.158	0.222	0.170	0.167

2010	0.161	0.180	0.302	0.269	0.137	0.184	0.144	0.142
2011	0.139	0.174	0.299	0.258	0.110	0.164	0.123	0.142
2012	0.152	0.198	0.307	0.275	0.125	0.201	0.134	0.159
2013	0.174	0.206	0.318	0.279	0.155	0.215	0.150	0.166
2014	0.175	0.219	0.314	0.285	0.165	0.229	0.142	0.183
2015	0.190	0.252	0.317	0.314	0.186	0.286	0.158	0.209

From the overall perspective of manufacturing, since 2005, the position of the US manufacturing industry in the GVC division of labor has shown a trend of first decreasing and then rising, but the overall volatility is not large (See Table 2). In the past 10 years, the position of the GVC of manufacturing industry has only increased The GVC index of the U.S. manufacturing industry is positive and has a large value, which shows that the U.S. manufacturing industry is still in the upstream position of the GVC and has a high international division of labor. It mainly obtains more High yield. However, with the rapid rise of emerging economies represented by China, the importance of US manufacturing in the division of labor in the GVC is declining. The position of China's manufacturing industry in the GVC division of labor has been rising, from 0.111 in 2005 to 0.252 in 2015, an increase of 0.141 in 11 years. Since 2006, the position of the division of labor in the technology industry has surpassed the United States and has been in the lead. The status and the gap have increased slightly every year. It is worth noting that the high-tech industry showed a significant growth trend from 2005 to 2009, see (Figure 3). In 2009, the position index of China's manufacturing industry in the GVC division of labor surpassed that of the United States for the first time. Since then, the gap has continued to widen. In 2010, the added value of China's manufacturing industry also surpassed the United States for the first time, becoming the world's largest manufacturing country.

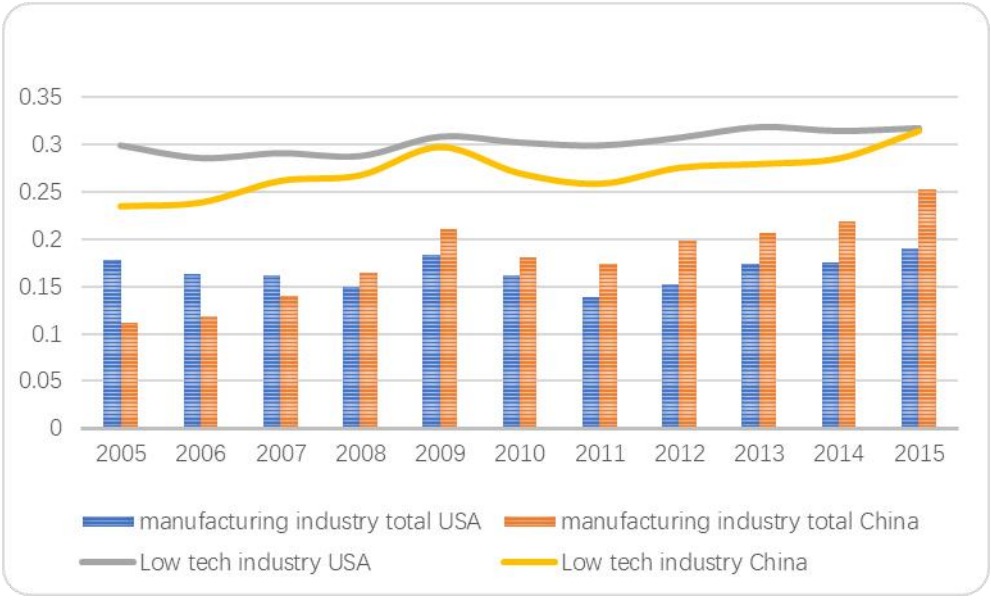

Figure 1 The position of low tech industry division between China and the United States

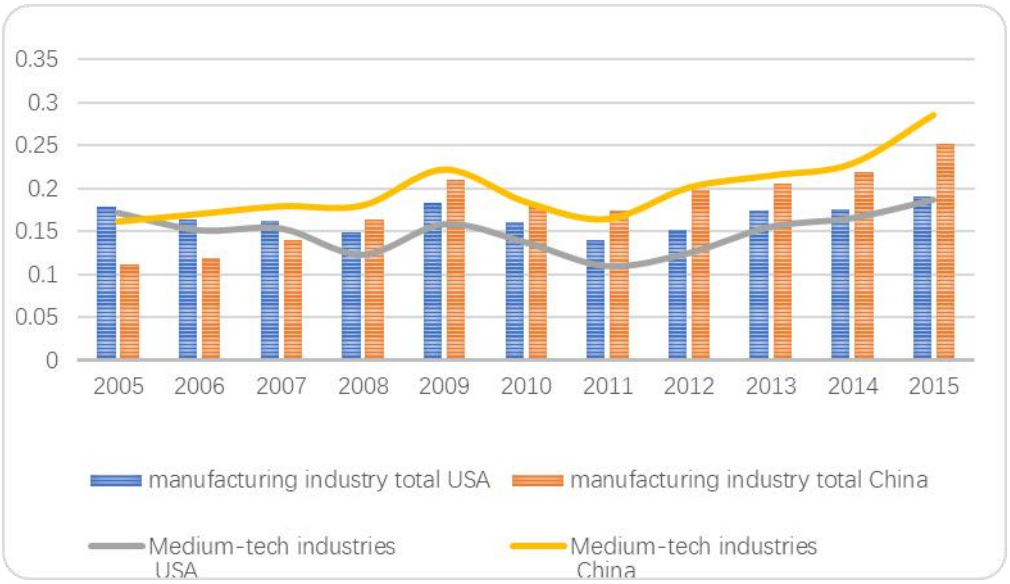

Figure 2 The position of medium tech industry division between China and the United States

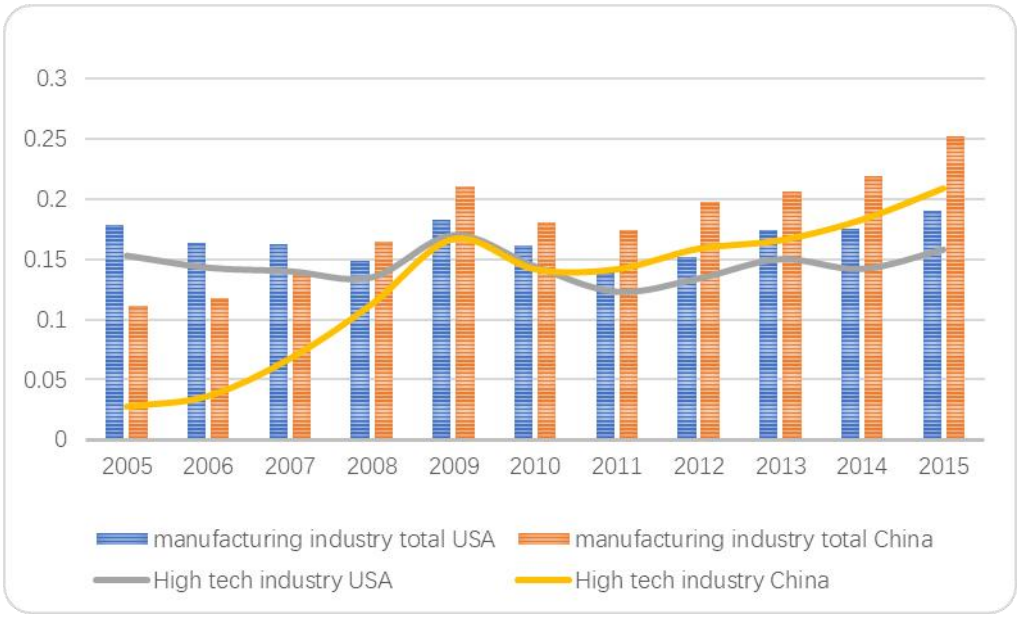

Figure 3 The position of high tech industry division between China and the United States

According to the calculation results of different types of manufacturing industries, whether it is a low-tech industry, a medium-tech industry or a high-tech industry, the position of the United States in the division of labor in the GVC has not fluctuated much. The trend is that China's high, medium and low-tech industries have increased their position index in the GVC division of labor. Among them, the position index of the high-tech industry in the GVC division has increased the most, from 0.028 to 0.208. From the perspective of the evolution process of the position index of the GVC of different industries, there are differences in their evolution paths. First of all, the division of labor in China's low-tech industry has shown a floating upward trend (Figure 1), gradually equalizing the division of labor in the low-tech industry in the United States. The gap narrowed from 0.065 in 2005 to 0.003 in 2015, indicating that China's low-tech industry Shanghai has reached a better position. Secondly, the growth of the Chinese technology industry is also more obvious. In 2006, the position index of Chinese technology industry in the GVC division of labor exceeded that of the United States (Figure 2). At that time, the total manufacturing industry still had a significant gap with the United States.

The development of the Chinese technology industry provides a strong impetus for the development of the Chinese manufacturing industry. The division of labor in the Chinese technology industry has been higher than that in the United States since 2006, and the gap has continued to widen from 0.019 in 2006 to 0.1 in 2015. The high-tech industry surpassed the United States in 2011, and then showed a steady growth trend (Figure 3). Compared with the low-tech industry, the division of labor in the GVC is still lower than that of the United States. This shows that the United States still occupies a smile curve in some industries of manufacturing. Both ends. Judging from the comparative advantages of high, medium and low industries, China's medium-tech industry has a large advantage, and this advantage has a trend of continuous expansion. The focus of competition in different types of industries is different. Low-tech industries mainly focus on competition in brands, design, and marketing. The medium and high-tech industry has more subdivided technical fields. At present, in addition to some high-end areas, such as chips, artificial intelligence, pharmaceutical manufacturing, new materials and other industries lag behind the United States, most other industries have a certain advantage.

3.2 Comparative Analysis of GVC Participation Models Between China and the US

Table 3 Comparison of Overall Participation Modes of the Manufacturing Industry

	Forward Participation		Backward Participation		Total Participation	
	China	U.S.	China	U.S.	China	U.S.
2005	0.436	0.391	0.284	0.165	0.720	0.556
2006	0.439	0.383	0.279	0.175	0.718	0.558
2007	0.457	0.389	0.266	0.181	0.723	0.570
2008	0.468	0.390	0.246	0.198	0.713	0.589
2009	0.493	0.387	0.210	0.155	0.703	0.541
2010	0.469	0.383	0.226	0.177	0.695	0.560
2011	0.467	0.383	0.233	0.204	0.700	0.586
2012	0.490	0.395	0.223	0.199	0.713	0.594
2013	0.496	0.409	0.218	0.184	0.714	0.593
2014	0.505	0.406	0.209	0.181	0.715	0.586
2015	0.528	0.399	0.187	0.156	0.714	0.555

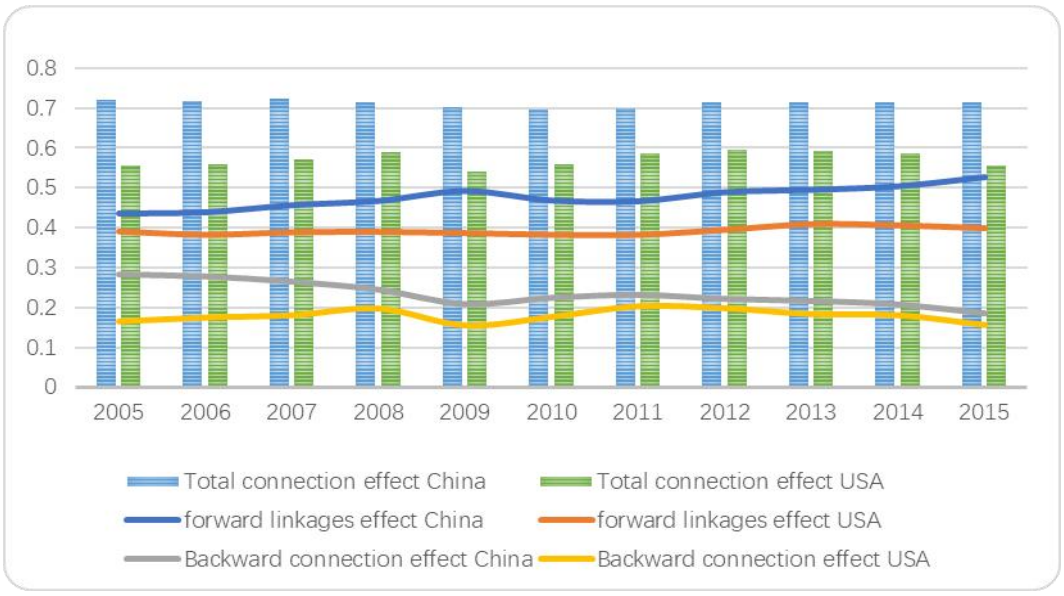

Figure 4 A comparison of global value chain participation models between China and the United States

Since 2005, the overall participation of manufacturing industries in China and the United States has not changed much (See Table 3). The United States has maintained between 55% and 60% in most years, while China has maintained around 70%. China ’ s manufacturing industry has participated in the GVC. The degree is much higher than that of the United States, which shows that China plays the role of both a major importing country and an exporting country, and its pivotal role and intermediary role in the division of labor in the GVC of manufacturing are constantly increasing. From the perspective of the embedded model of the GVC of manufacturing, since 2005, the forward participation of the manufacturing industries in China and the United States has been much higher than the backward participation, and there is a trend of rising fluctuations. The difference increased from 0.045 in 2005 to 0.129 in 2015, which also illustrates China's important position in global manufacturing (See Figure 4).

3.3 Backward Participation of China and the United States

The forward participation rate of the manufacturing industries of the two countries accounts for about 70% of the overall participation rate. At present, they are mainly embedded in the GVC in the forward embedding mode. Although the 2008 financial crisis, the United States has vigorously promoted the return of industrialization and high-end manufacturing Strategy, but in the past 10 years, the forward and backward participation of the US manufacturing industry has not changed significantly. The development model of the manufacturing industry has solidified and it is difficult to change it in the short term. The embedding model of China's manufacturing industry has undergone major changes. The forward participation rate increased from 43.6% in 2005 to 52.8% in 2015, and the backward participation rate decreased from 28.4% in 2005 to 18.7% in 2015. It has dropped by about 10 percentage points, which shows that since China’ s accession to the WTO, China’ s manufacturing industry has gradually moved to the upstream link of the GVC. With the continuous improvement of the technological level and competitiveness of China's high-tech manufacturing industry, China's manufacturing GVC's dependence on foreign countries is declining, while other countries' dependence on Chinese manufacturing is rising. China is shifting from an extensive manufacturing development model based on processing trade at the beginning of its WTO accession to a high-quality manufacturing development model based on design, technology and brand. With its advantages in product manufacturing and factor endowments, China has accelerated the process of division of labor in the GVC led by intra-product division of labor and trade. In addition, China relies on the advantages of manufacturing scale, production, technology and collaboration, effectively connecting the different value chain links of the GVC, realizing the multiple circulation and leap of export products at different levels of the GVC, extending China's manufacturing industry. The GVC has also deepened the connection between China's manufacturing industry and the GVC, and strengthened the role of China's manufacturing industry in the GVC (See Table 4).

Table 4 Comparison of Participation of Manufacturing Industries

	Low-tech Industry		Middle-tech Industry		High-tech Industry	
	Total Participation					
	U.S.	China	U.S.	China	U.S.	China
2005	62.90	64.32	58.22	69.26	52.75	76.87
2006	61.53	63.71	59.07	69.89	52.93	76.94
2007	63.01	64.11	60.30	70.12	53.97	77.22
2008	64.52	62.22	63.17	69.51	54.66	76.47
2009	59.95	60.46	56.39	68.61	51.34	75.98
2010	62.80	58.48	59.80	67.98	51.53	75.27
2011	66.44	59.49	62.85	69.00	52.91	75.64

2012	67.08	60.08	62.82	69.81	54.53	77.01
2013	66.71	59.60	62.92	70.69	54.08	77.01
2014	66.34	59.76	60.94	70.78	54.74	77.03
2015	64.42	61.19	55.35	70.35	53.42	76.39

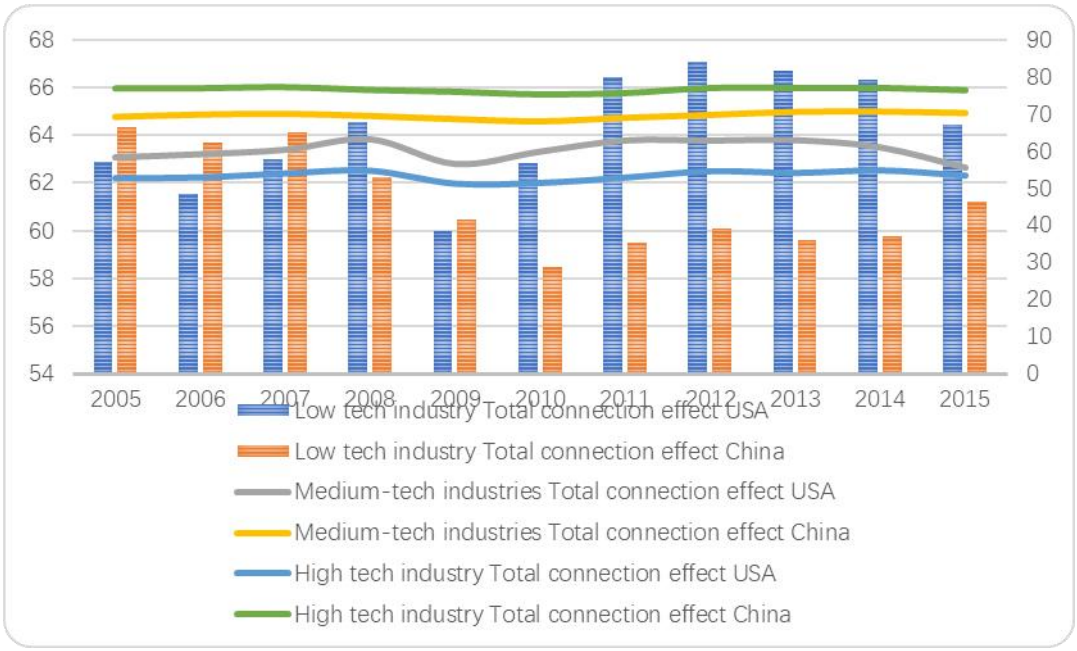

Figure 5 Comparison of China and US manufacturing industry participation by industry

In order to refine the research results, the total manufacturing participation of China and the United States is now compared again according to the technical level (See Figure 5). From the perspective of GVC participation of different industries, there are large differences between industries. The participation of low-tech industries in the United States is higher than that of medium and high-tech industries. From 2005 to 2015, this situation has been maintained for a long time. The participation of the technology industry is the lowest, and there is no major fluctuation in 10 years. This shows that the structure of the US manufacturing industry is dominated by high-tech industries, and the main manufacturing industries are computers, electronics, and optical products. Development mainly focuses on high-end links in the GVC such as design, branding, and marketing. Most of the manufacturing links take the form of outsourcing. Their reliance on foreign value chains is high, and the embedding of GVCs in low-tech industries is gradually increasing. The trend is that low-tech industries are more closely linked to GVCs, while middle- and high-tech industries, especially high-tech industries, are less dependent on foreign value chains. Compared with the United States, China's situation is exactly the opposite. China's low-tech industry's participation is lower than that of the medium-tech industry and the high-tech industry. The low-tech industry mainly plays the role of pure export, and the low-tech industry's GVC embedding degree is continuously decreasing. Foreign value chains are less dependent, while high-tech industries play a dual role of imports and exports. Their links with foreign value chains are closer, and their degree of embedding in GVCs remains basically unchanged. Comparing the total participation of low-tech industries in China and the United States, the United States began to surpass China in 2008. At the same time, China's total participation in the manufacturing industry has shown a downward trend, indicating that the United States is increasingly relying on the production model of OEMs in other countries. In terms of technology manufacturing, both China and the United States have stabilized, and the gap has remained basically unchanged. This shows that both China and the United States have shown good development momentum in the high-tech industry.

Table 5 Comparison of Participation Modes of Manufacturing Industries by Industry

	Forward dependence	Forward dependence	Backward dependence	Backward dependence	Forward dependence	Forward dependence	Backward dependence	Backward dependence	Forward dependence	Forward dependence	Backward dependence	Backward dependence
	U.S.	China	U.S.	China	U.S.	China	U.S.	China	U.S.	China	U.S.	China
2005	50.93	47.58	11.97	16.74	40.15	45.43	18.07	23.84	36.02	40.38	16.73	36.49
2006	49.33	47.47	12.20	16.25	39.29	46.38	19.79	23.52	35.51	41.05	17.43	35.89
2007	50.52	49.17	12.49	14.94	40.08	47.12	20.22	22.99	35.84	43.30	18.13	33.92
2008	51.17	48.51	13.35	13.71	39.68	46.85	23.49	22.66	35.90	46.01	18.76	30.46
2009	49.87	49.43	10.08	11.02	38.28	49.18	18.11	19.43	36.31	49.49	15.04	26.49
2010	51.09	46.54	11.71	11.94	38.76	46.26	21.04	21.72	34.79	47.38	16.74	27.89
2011	53.00	46.41	13.45	13.08	38.63	45.52	24.22	23.48	34.21	47.57	18.70	28.07
2012	53.88	47.78	13.20	12.29	39.63	48.43	23.19	21.38	35.79	49.50	18.74	27.50
2013	54.36	47.81	12.36	11.79	41.61	49.83	21.31	20.86	36.55	50.00	17.53	27.01
2014	53.89	48.27	12.45	11.48	41.23	50.85	19.71	19.93	36.39	51.12	18.35	25.91
2015	52.97	50.94	11.45	10.25	39.53	54.36	15.82	16.00	36.68	52.59	16.74	23.80

Judging from the embedding models of different industries, since 2005, the embedding models of low-, medium-, and high-tech industries in the United States have not changed much (See Table 5). The low-tech industry mainly uses the forward embedding model to participate in the GVC division of labor. The forward participation rate accounts for over 80% of the overall participation rate. The medium-tech industry and the high-tech industry present the results of the joint promotion of forward participation and backward participation. China's low-tech industry's forward participation rate has slightly increased, and its backward participation rate has dropped significantly, making the low-tech industry's GVC division of labor position continuously rising. Similar to the situation in the United States, China mainly uses forward participation to integrate into the GVC division of labor, and the forward participation rate accounts for more than 80% of the overall participation rate. The proportion of China’s mid-tech industry’s forward participation rate in the overall participation rate has gradually increased, reaching 77.3% in 2015, while the backward participation rate in the overall participation rate has decreased year by year. This shows that as the industry continues to upgrade, the degree of dependence of industrial exports on foreign value chains has gradually decreased, and independent production capacity has continued to increase. The Chinese technology industry is mainly integrated into the GVC through forward embedding, which is similar to the situation in the United States. The embedding model of China's high-tech industry has changed greatly in the past 10 years, and the forward participation rate has been greatly improved, while the backward participation rate has dropped significantly. This shows that China's high-tech industry has achieved rapid development, industrial technology level and industrial innovation ability have been greatly improved. The development of high-tech industry has changed from relying heavily on imported intermediate products in the past to reducing intermediate import dependence and independent innovation. Industry will become the main direction of the transformation and upgrading of China's manufacturing industry and the focus of future economic development. The rapid development of China's mid- and high-tech industries is mainly due to the industrial upgrading strategy vigorously promoted by the Chinese government. From the perspective of the development experience of advanced manufacturing in Japan, Germany, and South Korea, industrial policies are crucial to the development of mid- and high-tech industries. China can combine with the actual situation of its own manufacturing development, and has issued a series of manufacturing development plans and policies to promote the transformation of the manufacturing development model in an orderly manner. Among them, "China Manufacturing 2025" is the most typical representative of this series of industries. The upgrade strategy has accelerated the pace of China's manufacturing industry's transition to high-end in

the GVC.

3.4 Synergy analysis of Sino-US GVC

3.4.1 Comparison of the regional structure of the sources of value added of manufacturing exports abroad between China and the United States

In order to investigate the degree of connection between China and the United States and between China and the United States and the rest of the world ’s value chain, we first calculated the source structure of China ’s and U.S. manufacturing exports ’value-added abroad. Here we divide the world into Europe, the Americas, east and southeast Asia, and the rest of the world. Meanwhile, we separately calculate the proportion of the added value of the Americas manufacturing exports from China and that of Chinese manufacturing exports from the United States. The proportion of U.S. manufacturing export value added from China increased from 8.64% in 2005 to 18.94% in 2015, an increase of 10.3 percentage points in 11 years. The value added of China's manufacturing exports abroad from the United States has only increased by 1.27 percentage points in 11 years. This shows that the dependence of U.S. manufacturing exports on China is increasing. Nearly one-fifth of the added value of U.S. manufacturing exports comes from China, and the dependence of Chinese manufacturing exports on the United States is relatively small. From the perspective of the source structure of China's manufacturing industry's export value-added abroad, the value added of US manufacturing industry's export value-added from East and Southeast Asia is the highest, reaching 33.28% in 2015. Followed by the Americas, Europe and the rest of the world, the proportion of value added from East Asia and Southeast Asia shows a gradual increase, and the proportion of the value added from Europe and other regions of the world has decreased, which shows that US manufacturing exports to East Asia , Southeast Asia and the Americas have strong dependence on the value chain. East and southeast Asia accounted for the highest proportion of the added value of China's manufacturing exports abroad, reaching 41.59 percent in 2015, followed by the rest of the world, the Americas and Europe. The proportion from other parts of the world increased by a large margin, the proportion from the Americas increased by a small margin, and the proportion from east Asia and southeast Asia gradually declined. This shows that China's manufacturing exports are more dependent on the value chain in east Asia and southeast Asia. At the same time, with the development of the belt and road and the in-depth implementation of international production capacity cooperation, the GVC of China's manufacturing industry is also expanding from domestic to regional value chain of countries along the One Belt One Road (See Table 6).

Table 6 Comparison of the regional structure of sources of value added of manufacturing exports from China and the United States

	The regional structure of American manufacturing export value added abroad（%）					The regional structure of China's manufacturing export value added abroad（%）				
	China	Europe	the Americas	East and southeast Asia	other regions	U.S.	Europe	the Americas	East and southeast Asia	other regions
2005	8.64	26.09	27.59	27.67	18.65	9.86	16.88	14.75	51.56	16.80
2006	9.33	24.60	28.16	26.50	20.74	10.05	16.25	15.06	49.59	19.10
2007	9.95	24.09	28.44	26.25	21.22	9.64	16.70	15.70	47.31	20.29
2008	10.58	21.90	27.36	24.02	26.72	9.23	17.37	15.62	41.29	25.72
2009	11.04	21.48	29.22	25.15	24.15	9.30	16.87	16.29	43.97	22.87
2010	10.26	19.89	30.32	23.71	26.08	8.95	15.09	16.55	41.66	26.69
2011	10.35	19.01	31.15	22.41	27.42	8.41	15.71	16.49	37.70	30.10
2012	11.25	18.83	30.38	23.83	26.96	8.74	16.49	16.17	37.81	29.53

2013	13.22	18.59	30.89	25.39	25.13	9.27	16.08	16.30	37.91	29.70
2014	14.69	19.57	30.47	27.64	22.31	9.51	17.41	16.48	37.70	28.42
2015	18.94	21.52	29.19	33.28	16.01	11.13	17.64	17.86	41.59	22.91

3.4.2 Proportion of foreign added value of Chinese and American manufacturing exports

Further, in order to investigate the contribution of China and the United States to the added value of exports to other countries and regions in the world, we calculate the proportion of China and the United States in the added value of exports from other countries and regions in the world. Since 2005, the proportion of China ’s foreign added value in exports from Europe, the Americas, Asia and other regions of the world has gradually increased, and the increase is relatively large, with the largest increase in the Americas, reaching 15.45 percentage points, mainly from the United States 's contribution. East and southeast Asia came in second, up 13.36 percent. And it was 9.27 percent in Europe. n absolute terms, China's contribution to the value chain of east and southeast Asian countries is the largest, followed by the Americas and other regions of the world, and its contribution to the value chain of Europe is relatively small. This shows that most countries and regions in the world are importing more intermediate products from China, and their dependence on China's manufacturing value chain is increasing. China's manufacturing capacity is strengthening, which has been recognized by more and more countries. Comparing the changes of China from the United States over the years, the proportion of the United States in the value added of exports from East Asia and Southeast Asia, the Americas and other parts of the world has generally been gradually decreasing. From 2005 to 2015, they fell by 3.59%, 2.6% and 0.28% respectively. The decline is modest, but it is a sign of weakening demand for American-made goods in southeast Asia and the United States. Compared with the rising trend of China, especially the increase in the proportion of export value added of 15.55% in the United States, it also shows the strong vitality of Chinese manufacturing in export. The United States has a small increase in Europe, but the annual fluctuations are relatively large. From the perspective of absolute contribution, the American countries have the largest contribution to the value chain, followed by Europe, East Asia, and Southeast Asia, which has the smallest contribution to the value chain of the rest of the world. Therefore, overall, in the past 10 years, the degree of US contribution to other countries and regions in exporting value-added abroad has not changed much, and the degree of value chain connection between the United States and major countries and regions in the world has been declining. This is exactly the opposite of China ’s situation. With the continuous expansion of the manufacturing scale and the in-depth advancement of the Belt and Road Initiative, China ’s value chains with most countries and regions in the world are becoming closer and closer, which will help to improve the position in the GVC (See Table 7).

Table 7 Proportion of foreign added value of Chinese and American manufacturing exports

	Proportion of U.S. manufacturing value added in China and other regions （%）					Proportion of China ’s manufacturing value added in the U.S. and other regions （%）				
Time	China	Europe	East and southeast Asia	the Americas	other regions	U.S.	Europe	East and southeast Asia	the Americas	other regions
2005	9.86	22.30	22.51	47.04	12.94	8.64	8.88	15.85	11.75	7.60
2006	10.05	21.19	21.26	46.27	13.05	9.33	9.58	16.39	13.24	9.05
2007	9.64	20.34	19.32	44.12	12.59	9.95	11.47	18.19	14.30	9.95
2008	9.23	19.62	16.35	43.84	12.66	10.58	11.83	17.95	15.32	11.24
2009	9.30	24.11	18.25	44.89	13.73	11.04	12.09	19.88	16.86	11.83
2010	8.95	20.80	16.62	44.41	13.60	10.26	12.61	18.61	16.32	12.62
2011	8.41	18.92	14.68	42.73	13.22	10.35	12.54	19.15	16.63	13.30

2012	8.74	19.02	14.34	41.64	13.55	11.25	12.97	19.88	17.96	13.90
2013	9.27	20.15	14.76	44.38	13.09	13.22	14.21	21.14	20.69	15.53
2014	9.51	20.78	15.39	46.42	12.60	14.69	15.97	23.30	22.70	17.27
2015	11.13	23.90	18.92	44.44	12.66	18.94	18.15	29.21	27.30	20.37

3.4.3 Analysis of the dependence of GVCs on manufacturing industries in China and the United States

In order to explore the dependence relationship between China and the United States in the manufacturing industry, this study calculates the proportion of DVA exports between China and the United States and the former and latter dependence of Chinese manufacturing on the United States (See Table 8).

Table 8 Dependence of GVCs on manufacturing industries in China and the United States

	The proportion of China's manufacturing DVA exports to the U.S.	The proportion of American manufacturing DVA exports to China	China's manufacturing industry's forward dependence on the U.S.	The share of China's manufacturing exports of foreign value added to the U.S.	The share of the added value of us manufacturing exports to China	The backward dependence of China's manufacturing industry on the U.S.
2005	30.52	5.38	5.68	9.86	8.64	1.14
2006	28.58	6.07	4.71	10.05	9.33	1.08
2007	26.00	6.47	4.02	9.64	9.95	0.97
2008	22.87	6.51	3.51	9.23	10.58	0.87
2009	22.67	7.19	3.16	9.30	11.04	0.84
2010	21.39	7.85	2.73	8.95	10.26	0.87
2011	19.79	8.67	2.28	8.41	10.35	0.81
2012	20.38	8.79	2.32	8.74	11.25	0.78
2013	20.49	10.82	1.89	9.27	13.22	0.70
2014	20.75	12.05	1.72	9.51	14.69	0.65
2015	22.50	13.40	1.68	11.13	18.94	0.59

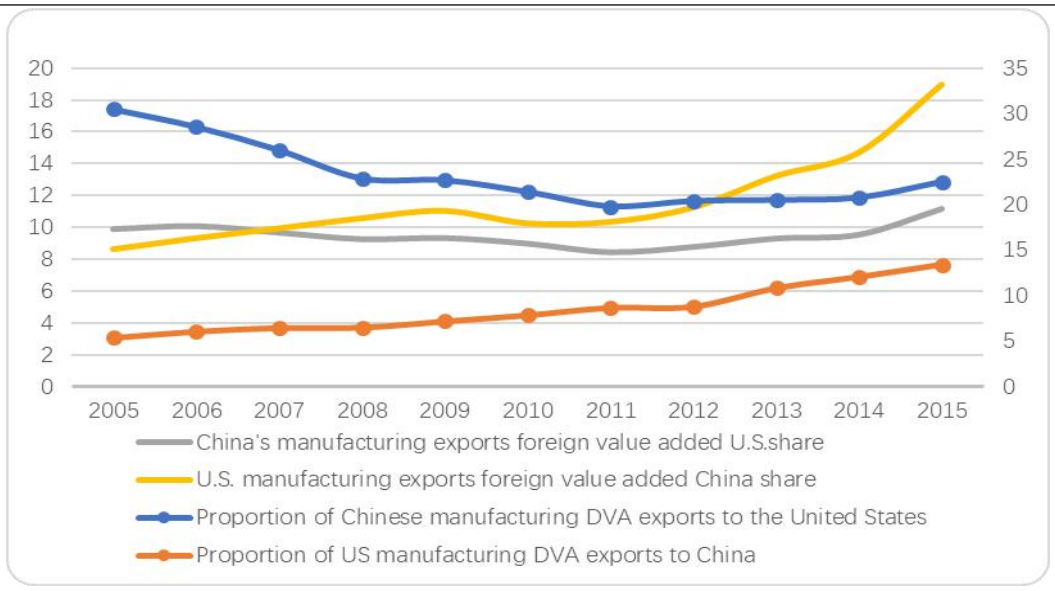

Figure 6 Comparison of manufacturing exports between China and the United States

The proportion of China's manufacturing DVA exports to the United States declined from 30.52 in 2005 to 22.50 (Figure 6). Combined with the data presented in table 7, it can be found that while the proportion of China's exports to the United States is decreasing, the proportion of added value of China's manufacturing exports in other regions is significantly increasing, which indicates that with the introduction of One Belt One Road and other national strategies, the direction of China's manufacturing exports is also changing. Since 2005, the proportion of DVA exports to China in the manufacturing industry of the United States has been steadily increasing year by year, increasing from 5.38 in 2005 to 13.40 in 2015. Comparing China and the United States manufacturing exports increase worth share chart, China's export value-added share in the United States has remained basically stable for 10 years. Although there are fluctuations, but the fluctuations are not obvious, and the share of US exports to China has increased significantly in the past 10 years, indicating that China is gradually becoming one of the US countries that focus on manufacturing exports, and trade is getting closer.

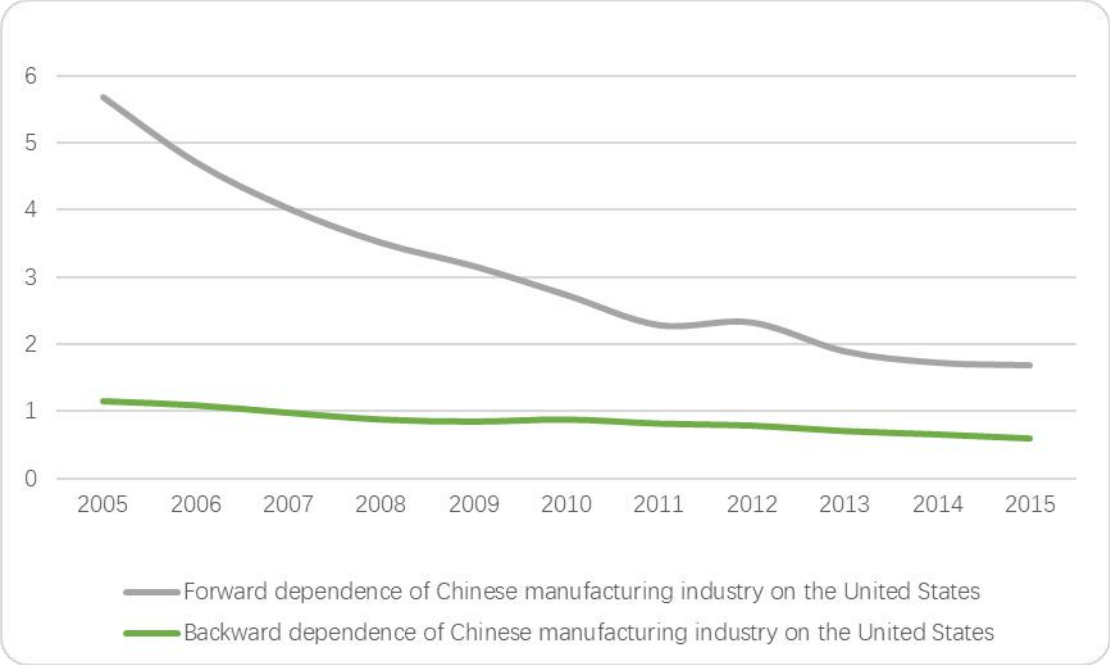

Figure 7 Dependence of Chinese manufacturing on the United States

Based on the analysis of the dependence of Chinese manufacturing industry on the United States, Figure 7 shows that the dependence of Chinese manufacturing industry on the United States shows a decreasing trend. The forward dependence degree decreased significantly from 5.68% in 2005 to 1.68% in 2015. It can also be speculated that China's export intention to the United States in the manufacturing sector is decreasing year by year, which may have shifted the main export direction to the manufacturing sector.

3.5 Grey Relational Analysis of factors influencing the location of GVC division of Labor in Sino-US manufacturing

In order to discuss the differences between the factors affecting the GVC division of labor in manufacturing industries in China and the United States, this article uses gray correlation analysis to analyze the existing factors. The factors affecting the GVC division of labor mainly consider per capita GDP, R & D expenditure, exports of goods and services, imports of goods and services, ore and metals exports. The calculation results of gray correlation are shown in the following Table 9-11.

Table 9 The calculation results of the gray correlation coefficient between different influencing factors and the division

of labor in China's GVC

Year	GDP	R&D spending	Exports of goods and services	Imports of goods and services	Exports of Ore and metal
2005	1.0000000	1.0000000	0.3333333	0.3706881	0.9606442
2006	1.0000000	1.0000000	0.3682219	0.4268588	0.9488031
2007	1.0000000	1.0000000	0.4597623	0.5384225	0.9768676
2008	1.0000000	1.0000000	0.6010014	0.6710655	0.9908318
2009	1.0000000	1.0000000	0.3333333	0.3706881	0.9606442
2010	1.0000000	1.0000000	0.3682219	0.4268588	0.9488031
2011	1.0000000	1.0000000	0.4597623	0.5384225	0.9768676
2012	1.0000000	1.0000000	0.6010014	0.6710655	0.9908318
2013	1.0000000	1.0000000	0.3333333	0.3706881	0.9606442
2014	1.0000000	1.0000000	0.3682219	0.4268588	0.9488031
2015	1.0000000	1.0000000	0.4597623	0.5384225	0.9768676
Average	1.0000000	1.0000000	0.425995936	0.4863672	0.967328027

Table 10 Calculation results of gray correlation coefficients between different influencing factors and the status of the U.S. GVC

Year	GDP	R&D spending	Exports of goods and services	Imports of goods and services	Exports of Ore and metal
2005	1.0000000	1.0000000	0.5452098	0.3721648	0.5741569
2006	1.0000000	1.0000000	0.6208813	0.3707692	0.9346003
2007	1.0000000	1.0000000	0.8433481	0.4200766	0.9438455
2008	1.0000000	1.0000000	0.6565636	0.3333333	0.8643956
2009	1.0000000	1.0000000	0.5452098	0.3706881	0.5741569
2010	1.0000000	1.0000000	0.6208813	0.3721648	0.9346003
2011	1.0000000	1.0000000	0.8433481	0.4200766	0.9438455
2012	1.0000000	1.0000000	0.6565636	0.3333333	0.8643956
2013	1.0000000	1.0000000	0.5452098	0.3721648	0.5741569
2014	1.0000000	1.0000000	0.6208813	0.3707692	0.9346003
2015	1.0000000	1.0000000	0.8433481	0.4200766	0.9438455
Average	1.0000000	1.0000000	0.667404073	0.377783391	0.826054482

Judging from the gray correlation coefficients of different factors in China and the United States on the division of labor in the GVC, GDP and R & D expenditure have the highest correlation, and the export of goods and services has a greater impact on the location of the division of labor in the U.S. GVC (See Table 10). Per capita GDP is an important indicator to measure the economic development level of a country. The higher per capita GDP a country has, the more high-end production factors it will master, which will facilitate its participation in the division of labor in the GVC, and the higher its position in the division of labor in the GVC. From the development experience of developed countries, R & D investment is an important means to maintain and enhance a country's technological competitiveness. The higher a country ’s R & D investment, the higher its innovation capability and technical level, and the countries with higher innovation capability and technical level have higher technological level and more competitive export products.

High-tech products are usually Located in the mid-to-high end of the GVC, it can obtain more GVC benefit distribution, and at the same time it is more conducive to a country's participation in the GVC. Therefore, if a country wants to improve its division of labor in the GVC, it is essential to increase GDP. At the same time, it should pay attention to the improvement of its research and development capabilities, increase investment in research and development, and maintain its technological competitiveness. In addition, natural resource endowment also has a greater impact on a country's GVC division of labor status. To a certain extent, it determines the mode and degree of a country's participation in the GVC division of labor. The richer a country's resources, the more beneficial it is to participate in the GVC, and its position in the GVC division of labor is also higher. Therefore, some countries with abundant natural resources can reasonably develop their natural resources and give full play to their competitive advantages in the GVC.

Table 11 Gray correlation entropy and entropy change value

	Grey relation entropy		Entropy Change	
Year	China	U.S.	China	U.S.
2005	1.509573	1.541658		
2006	1.528765	1.55285	0.019192	0.011192
2007	1.559523	1.570529	0.030758	0.017679
2008	1.586666	1.548552	0.027143	-0.021977
2009	1.509573	1.541658	-0.077093	-0.006894
2010	1.528765	1.55285	0.019192	0.011192
2011	1.559523	1.570529	0.030758	0.017679
2012	1.586666	1.548552	0.027143	-0.021977
2013	1.509573	1.541658	-0.077093	-0.006894
2014	1.528765	1.55285	0.019192	0.011192
2015	1.559523	1.570529	0.030758	0.017679

Based on the calculated gray correlation density value, this study calculates the gray correlation entropy and the entropy variation value over the years. The calculation results are shown in Table 11. From the perspective of variable value results, in an open system composed of GVC and its influencing factors, the complex interactions among various elements form a nonlinear mechanism of the system, and the fluctuations and mutations that lead to an increase or decrease in entropy are mainly It comes from the impact and impact on the system. Overall, from 2005 to 2015, the entropy changes of the gray correlation between the division of labor in the GVC between China and the United States and its influencing factors experienced several positive and negative alternations. In China, the gray correlation entropy turned negative for two years in 11 years, and in the United States, it turned negative for four years in 11 years. In these years, per capita GDP, R&D expenditure and import and export trade have brought negative entropy flow to the promotion of the division of labor in the GVC between China and the United States. This shows that per capita GDP, R & D expenditure, import and export trade, etc. have formed a certain degree of orderly synergy with the division of labor in the GVC, and the synergy in the United States is more obvious.

4. CONCLUSIONS AND SUGGESTIONS

Based on the perspective of added value trade, this paper uses the latest added value trade data from OECD-TIVA database to measure the positions and participation modes of manufacturing industries and their sub-industries in the division of GVC between China and the United States. The results are as follows: First, China's manufacturing industry in the GVC division of labor status rise ceaselessly, the added value of China's manufacturing and prior to engagement are obtained remarkable growth, annual export growth is much higher than the United States, and in 2009 China's manufacturing industry position in the GVC specialization index for the first time more than the United States. After the

widening gap, the added value of China's manufacturing industry surpassed that of the United States for the first time and became the world's top manufacturing power in 2010. However, the performance shows that China's manufacturing industry has the first export structure, mainly low technology manufacturing. Until recently, it gradually turned to the high and high technology manufacturing industry, Technology manufacturing also saw the most significant increase in forward participation in the year. Second, Europe and Southeast Asia will become the key battlefields of sino-US trade game. Through the analysis of the results and the study of performance evaluation, it is not difficult to find that the added value of China's manufacturing industry and the export structure of the United States to Europe and Southeast Asia are large, while the manufacturing export structure increases, the index ratio increases significantly. It shows that the two countries all take a fancy to the market in these countries, so the hard to avoid in the future will appear a lot of competition in these areas. Third, China's manufacturing industry status in GVC and the United States is increasingly closer to total involvement in manufacturing is higher than the United States for a long time, China and the United States and China manufacturing total participation are stable, through the data can be found in China in 2005, mainly manufacturing low technology, through 10 years of development, high-tech manufacturing in China increase prior to participation, backward participation also showed a trend of stability reduced, while the United States in the manufacturing industry, high technology in forward participation without significant changes, means China's manufacturing industry is in the GVC low-end to high-end link up. Fourth, China and the United States show opposite trends in manufacturing exports. Since 2005, the proportion of China's manufacturing DVA exports to the United States has gradually declined, while that of the United States' manufacturing DVA exports to China has gradually increased, indicating that China is gradually changing its export direction, while the degree of dependence of the United States on China has been steadily increasing.

In the future, China and the United States manufacturing game may be more competitive in the GVC through the above analysis shows that with the improvement of industrial level and degree of opening to the outside world, along with China's policies issued and implemented, the scale of China's manufacturing industry is rising steadily, export quantity is also increasing, become the world's largest exporter of manufactured goods, at the same time their participation in GVC are also growing, technology in the manufacturing industry and high-tech manufacturing industry exports and engagement also increased significantly. However, with the increase of export scale and participation degree of GVC, the division of labor status of GVC has not increased significantly. Moreover, it is not difficult to find that there is still a gap between the manufacturing industries of China and the United States by comprehensively comparing the division of labor status of Chinese and American manufacturing industries in the GVC.

In order to practice the strategy of "manufacturing power" and achieve higher and faster development of Chinese manufacturing industry, the suggestions based on the above conclusions are as follow. First, on the premise of steadily improving manufacturing overall participation ascend emphatically forward participation, especially in technology manufacturing and high technology manufacturing prior to engagement, thus improve the status in the international division of labor. Second, it’s necessary to continue to strengthen the overall participation in the manufacturing industry in east Asia and southeast Asia, combine the strategy of "One Belt And One Road" to actively build the domestic value chain, and on this basis, extend the domestic value chain to neighboring countries and even the world, so as to improve the global position of China's manufacturing industry and occupy a larger market. Third, the two countries should make efforts to build a good market environment and clearly recognize the dependent relationship between the two countries, China's trade dependence, especially since 2005 the United States exports to China increased, more should break the trade barriers, strengthen cooperation and exchanges, and realize collaboration so as to reduce the trade friction in different ways.

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Hummels, D., J. Ishii and K. Yi, The nature and growth of vertical specialization in world trade. Journal of International Economics, 2001. 54(1).

[2] Daudin, G., C. Rifflart and D. Schweisguth, Who produces for whom in the world economy? Canadian Journal of Economics/Revue canadienned'économique, 2011. 44(4): p. 1403-1437.

[3] Koopman, R., et al., Give Credit Where Credit is Due: Tracing Value Added in Global Production Chains. NBER Working Paper Series, 2010.

[4] Yu Jue, A comparative study of the US-China manufacturing industry embedded in the global value chain under the background of US reindustrialization. Economist, 2017(11): pages 88-96.

[5] Li Yuan and JinDianchen, Comparison of International Competitiveness of Manufacturing Industries between China and the United States-Analysis Based on GVC Participation Index and GVC Status Index. Business Research, 2017(02): pages 79-87.

[6] Wang Lan, The influence of integration into the global value chain on the status of China’s manufacturing industry in the international division of labor. Statistical Research, 2014. 31(05): pages 17-23.

[7] Zhang Lan, Research on the Strategic Transformation of US Investment in China under the Global Economic Rebalancing, 2015, University of International Business and Economics.

[8] Liu Zhongli and Zhao Ying, the dependence of East Asia in the division of labor in the global value chain-an empirical analysis based on TiVA data. Nankai Economic Research, 2014(05): pages 115-129.

[9] Li Genqiang and Pan Wenqing, How domestic value chains are embedded in global value chains: A perspective of value added. Management World, 2016(07): Pages 10-22+187.

[10] Ni Hongfu, Gong Liutang and Xia Jiechang, The evolutionary path of production segmentation and its influencing factors——An investigation based on the number of production stages. Management World, 2016(04): Page 10-23+187.

[11] Sultani and Shao Chao, Global Value Chain Participation, Regional Economic Growth and Spatial Spillover Effects. International Trade Issues, 2017(11): pages 48-59.

[12] Li Shantong, He Jianwu and Liu Yunzhong, Research on China's Domestic Value Chain Division of Labor from the Perspective of Global Value Chain. Management Review, 2018. 30(05): pages 9-18.

[13] Liu Yanhua Research on the construction of enterprise R & D team performance evaluation system [J] Shandong human resources and social security, 2021 (12): 28-29.

[14] Liu Lei, Liu Zuoyi, Li Jiangtao Performance evaluation analysis of fund supported projects of the Ministry of Management Science in 2020 [J] Journal of management, 2021,18 (12): 1750-1755.

[15] Zhang Tao, sun fan, Yang Yang, Jin Minjie, Cheng Gang Performance evaluation of travel security system for people with low driving power under epidemic situation [J] Journal of Wuhan University of technology, 2021,43 (10): 27-33.

[16] Zhang Huiqing, The Impact of Asymmetric Changes in Major Currency Exchange Rates on Trade-A Study Based on the Global Vector Autoregressive Model. International Trade Issues, 2018(12): Pages 135-148.