

The impact of Two-way FDI on the upgrading of global value chain of China's manufacturing industry

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Abstract: Manufacturing industry is the leading industry in China's national economy. The participation of global value chain (GVC) in China's manufacturing industry is very high, whereas its GVC status is very low. The inward foreign direct investment (IFDI) and outward foreign direct investment (OFDI) are the main ways for China's manufacturing industry to integrate into the global value chain. Previous studies mainly focused on the upgrading of GVC in China's manufacturing industry from the perspective of single IFDI or single OFDI. This paper takes the perspective of "Two-Way FDI" as the starting point. Using the panel data of China's manufacturing sub-industries, this paper analyzes the mechanism of IFDI, OFDI and two-way FDI influencing GVC. The Fixed Effect Model is established to analyze the impact of IFDI, OFDI and two-way FDI on GVC upgrading of China's manufacturing industry.

1. Introduction:

According to the statistics of UNCTAD, the global value chain (GVC) trade accounts for 80% of the global trade. Participation in global value chain is the main way for China's manufacturing industry to participate in economic globalization and obtain international trade benefits. The inward foreign direct investment (IFDI) and outward foreign direct investment (OFDI) are the main ways for China's manufacturing industry to integrate into the global value chain. The introduction part focus on the research background, research content and research methods, domestic and foreign literature research theoretical results, as well as the theoretical and practical significance of the article.

1.1. Research background

With the continuous reduction of transportation costs and information exchange costs, more and more countries choose to put different production stages of products in different countries to achieve the purpose of minimizing production costs and maximizing benefits. GVC, whose core content is the international division of labor within the product, came into being. Developed countries have strong R & D and design capabilities, control the high value-added parts of products, and are in the high-end of GVC. However, due to the lack of product R & D and design capabilities, some developing countries can only engage in the assembly and processing of products with low added value, which is relatively low in GVC.

Therefore, the essence of GVC today is dominated by developed countries. Since the reform and opening up, China's manufacturing industry has continuously attracted foreign direct investment (FDI) by making use of low-cost labor force and abundant natural resources, thus embedding GVC led by developed countries. However, most of the foreign investment in China's manufacturing industry is engaged in product processing and assembly. Long-term work in these sites has caused China's manufacturing industry to fall into the predicament of product low-value-added lock-in (ie, GVC low-end lock-in). Manufacturing industry is one of the leading industries of China's national economy, which has an important impact on China's economic strength and international competitiveness. Therefore, improving the GVC status of China's manufacturing industry is an important task to enhance China's economic strength and international competitiveness. At present, on the one hand, China's labor costs are rising with China's economic development, and the lower labor costs in Southeast Asia are more attractive for foreign direct investment in manufacturing industry by developed countries. On the other hand, facing the risk of manufacturing hollowing out, many developed countries, such as the United States, Japan and Germany, have implemented the policy of manufacturing return. Thus, China's manufacturing industry is facing double pressure. According to the world investment bulletin 2019, the total amount of IFDI and OFDI in China in 2018 was 1390 trillion US dollars and 1300 trillion US dollars respectively, both ranking the second in the world. China has become the second largest

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host country and investor in the world. Both theory and practice have proved that IFDI and OFDI have an important impact on the GVC status of a country's industry. Then, what are the impacts of IFDI, OFDI and two-way FDI on the location of GVC in China's manufacturing industry? How can China's manufacturing industry use two-way FDI to enhance the position of GVC in China's manufacturing industry? Under the dual pressure, how can China's manufacturing industry break through the dilemma of low value-added products and complete the task of upgrading GVC status? These are the questions to be discussed in the article.

1.2. Research contents and methods

The main content of this paper is the impact of IFDI, OFDI as well as two-way FDI on the GVC status of China's manufacturing industry, and the measures to improve the GVC status of China's manufacturing industry by using two-way FDI. The method adopted is a combination of theory and empirical analysis. In the past, most of the literatures studied the upgrading of GVC in China's manufacturing industry from the perspective of single IFDI or single OFDI. This paper takes the perspective of "two-way FDI" as the starting point, first analyzes the mechanism of IFDI, OFDI and two-way FDI influencing GVC upgrading of China's manufacturing industry, using the panel data of China's 12 manufacturing sub-industries from the WIOD database. The Fixed Effect Model is established to analyze the impact of IFDI, OFDI and two-way FDI on GVC upgrading of China's manufacturing industry.

1.3. Literature review

1.3.1. *The impact of IFDI on GVC upgrading in manufacturing industry*

Many scholars at home and abroad have studied the impact of IFDI on GVC upgrading in manufacturing industry, and the conclusions are inconsistent. Some scholars believe that IFDI can promote the upgrading of manufacturing industry GVC. Kohpaiboon (2006) [1] found that FDI has a positive effect on the technology spillover of Thailand's manufacturing industry, and proposed that the liberalization of foreign investment policy and trade policy should be carried out at the same time, so as to maximize the technology spillover effect of FDI on Thai manufacturing industry. Takii (2011) [2] analyzed the impact of FDI from different economies on Indonesia's manufacturing industry. He found that manufacturing FDI from Asian economies can promote national economic growth and industrial upgrading better than that from non-Asian economies. Kevin (2014) [3] using the panel data of 21 manufacturing sectors in 31 regions of China. The study found that FDI can enhance the competitiveness of China's manufacturing industry, so as to enhance the position of GVC. Wang Yuanyuan (2019) [4] believes that market and creative FDI can promote GVC upgrading of China's medium and high-tech manufacturing industry. Some scholars think that IFDI

has hindered the upgrading of GVC in manufacturing industry. Keane, basnett (2016) [5] believed that although the introduction of FDI from developed countries can bring a lot of employment opportunities to the manufacturing industry of some developing countries, such as Cambodia and Nepal, the manufacturing industry of these countries may also face the risk that the production has been in the low-end stage, and it is difficult to realize GVC upgrading. Li Min (2019) [6] found that FDI will also make China's manufacturing industry face the dilemma of low-end GVC lock-in. Wu Yuhang (2016) [7], through the construction of the intermediary model of technology spillover, the study found that FDI has a very limited effect on China's manufacturing technology spillover.

1.3.2. *The impact of OFDI on GVC upgrading of manufacturing industry*

Many scholars at home and abroad have studied the impact of OFDI on GVC upgrading in manufacturing industry, and the conclusions are different. Some scholars believe that OFDI has a significant effect on GVC upgrading of manufacturing industry. Minin, et al (2012) [8] found that China's manufacturing industry would have reverse technology spillover effect on OFDI of European countries, thus enhancing the GVC status of China's manufacturing industry. Ma Xingzhi (2018) [9] used the method of double difference and propensity score matching to empirically study the relationship between OFDI for the "Belt and Road" countries and the improvement of the status of China's manufacturing GVC. The research results show that the OFDI of my country's manufacturing industry to the "Belt and Road" countries can improve its position in GVC. Liu Meng (2019) [10] takes Huawei as an example to study the path of improving GVC status of ICT industry in China through OFDI. It is concluded that the flow of talents and technology between the investor and the investee can promote the upgrading of GVC in China's ICT industry. Some scholars believe that OFDI has no significant effect on GVC upgrading of manufacturing industry. Liu Li (2017) [11] used the value-added rate to measure the process upgrading of the manufacturing industry, and used the vertical specialization index to measure the chain upgrading of the manufacturing industry. Neither of them found that OFDI had a significant effect on the GVC upgrading of China's manufacturing industry.

To sum up, a large number of literatures have studied the impact of FDI on GVC upgrading of manufacturing industry from the perspective of independent IFDI or independent OFDI. These rich research results have laid a solid theoretical foundation for the research of this paper. In view of the fact that few scholars study the impact of two-way FDI on the promotion of GVC status of manufacturing industry by combining IFDI angle and OFDI angle, this paper combines IFDI angle and OFDI angle to study the impact of bidirectional FDI on the promotion of GVC status of manufacturing industry in China. Theoretically, this paper studies the impact of IFDI, OFDI and their interaction on GVC upgrading of China's

manufacturing industry from the perspective of two-way FDI, which broadens the perspective of research on GVC upgrading of manufacturing industry and enriches the theory of GVC upgrading of manufacturing industry. In fact, China has become the second largest host country and investment country in the world, and the two-way FDI in China's manufacturing industry is also developing continuously. How to coordinate the two-way FDI and promote the upgrading of GVC in China's manufacturing industry is an urgent problem to be solved under the background of the national policy of "going out" and "bringing in". Based on the empirical research results, this paper puts forward the measures to coordinate the two-way FDI to enhance the GVC status of China's manufacturing industry, so as to provide reference for improving the GVC status of China's manufacturing industry.

2. The current situation of China's manufacturing direct investment and GVC

Manufacturing industry is one of the leading industries of China's national economy, which has a significant impact on China's economic strength and international competitiveness. The following part introduces the IFDI status of manufacturing industry, OFDI status of manufacturing industry, interactive and coordinated development level of two-way FDI in manufacturing industry, GVC participation and GVC status of manufacturing industry.

2.1. IFDI status of manufacturing industry

IFDI in China's manufacturing industry started early and has developed rapidly. It can be seen from Figure 1 that my China's manufacturing IFDI flow and the proportion of manufacturing IFDI flow in China's total IFDI flow show a trend of first rising and then falling. With the continuous promotion of reform and opening up, IFDI flow of China's manufacturing industry increased from US \$22.6033.4 billion to US \$49.894.83 billion from 1999 to 2008, an increase of about 1.2 times. During 2008-2009, affected by the global financial crisis, IFDI flow in China's manufacturing industry decreased by 31.2337 US dollars. After 2009, my China's manufacturing IFDI flow showed an upward trend. By 2011, my it's manufacturing IFDI flow reached the highest value, 52.105.4 billion US dollars. From 2011 to 2017, the flow and proportion of IFDI in China's manufacturing industry have shown a significant decline. There are three main reasons. First of all, the labor cost of nation's manufacturing industry continues to rise with economic development. From 2011 to 2017, the average salary of employed persons in urban units in China's manufacturing industry increased from 36665 yuan to 72088 yuan, approximately doubled. China's manufacturing industry is mainly attracted by some labor-intensive industries. Therefore, with the rise of labor costs in China's manufacturing industry, developed countries are more willing to invest labor-intensive industries in Southeast Asian countries with

lower labor costs than China. Secondly, faced with the risk of hollowing out domestic manufacturing industry caused by excessive OFDI, some developed countries have withdrawn their manufacturing industries in developing countries. For example, the United States' policy of "Re-industrialization" and Germany's industrial 4.0 policy have led to a substantial reduction of its investment in China's manufacturing industry. Finally, in recent years, the proportion of IFDI in China's service industry has continued to rise, resulting in a corresponding decline in the proportion of IFDI in nation's manufacturing industry. This also shows that the direction of China's introduction of FDI is more diversified and rationalized. In the context of Sino-US trade frictions, China's manufacturing IFDI flow in 2018 increased by about 22% compared with 2017, indicating that nation's manufacturing IFDI sources are vast and do not only depend on or subject to a certain country.

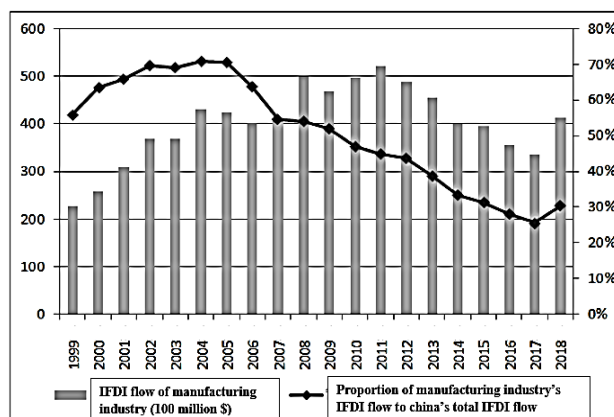


Figure:1 IFDI status of China's manufacturing industry, Source: National Bureau of statistics

2.2. OFDI status of manufacturing industry

At the beginning of reform and opening up, China implemented strict industry OFDI policy, only some state-owned enterprises were allowed to carry out OFDI. Therefore, compared with IFDI, OFDI of China's manufacturing industry started later and developed more slowly. With the gradual liberalization of OFDI restrictions, OFDI in China's manufacturing industry has developed rapidly. As can be seen from Figure 2, the OFDI flow of China's manufacturing industry showed an upward trend from 2003 to 2012, and the OFDI flow of manufacturing industry in 2012 increased by about 13 times compared with that in 2003. Affected by the European debt crisis, OFDI flow of China's manufacturing industry in 2012 decreased by 17% compared with 2013. From 2013 to 2017, OFDI flow of China's manufacturing industry increased rapidly, reaching the maximum value of 29.50737 billion yuan in 2017. The rapid growth of one belt, one road initiative in 2013, has been the main reason for the rapid growth of OFDI in China's manufacturing industry since 2013. Affected by the downturn of international investment environment, OFDI flow of China's manufacturing industry in 2018 decreased by about 30% compared with that in 2017. Although the OFDI flow of China's manufacturing industry has shown

a rising trend in recent years, the proportion of manufacturing OFDI in the total OFDI flow of China is less than 20%, which indicates that there is still a lot of room for the increase of OFDI flow in China's manufacturing industry. China's manufacturing industry should further "go out", gain more international benefits and enhance GVC status through "going out".

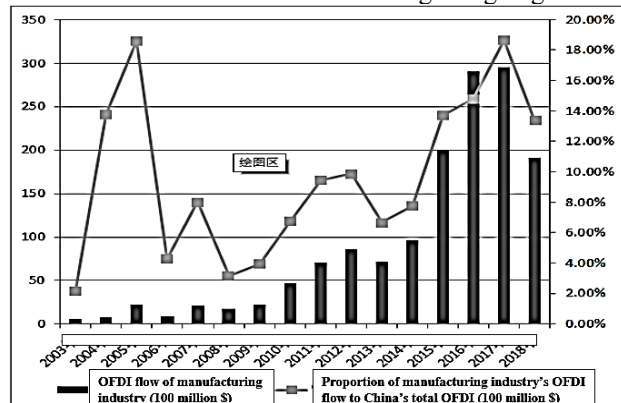


Figure: 2 OFDI status of China's manufacturing industry, Source: China's foreign direct investment bulletin 2003-2018

2.3. Manufacturing two-way FDI interactive and coordinated development level

The article draws on the formula of the development level of two-way FDI interaction proposed by Huang Lingyun, Liu Dongdong, and Xie Huiqiang (2018) [12] to measure the development level of two-way FDI interaction in my country's manufacturing industry from 2003 to 2018. The formula is as follows:

$$D(IO)_t = \left[\frac{IFDI_t * OFDI_t}{(IFDI_t + OFDI_t) / 2} \right]^{\frac{1}{2}} \quad (1)$$

In formula (1), $D(IO)_t$ represents the level of interactive and coordinated development of IFDI and OFDI in china's manufacturing industry in year t. The greater the value of $D(IO)_t$, the level of coordinated and interactive development of IFDI and OFDI is higher, on the contrary, its lower. $D(IO)_t > 100$ means that the level of interactive and coordinated development of IFDI and OFDI is relatively high, $D(IO)_t < 100$ means that the level of interactive and coordinated development of IFDI and OFDI is relatively low. $IFDI_t$ & $OFDI_t$ represent the IFDI flow and OFDI flow in the manufacturing industry in year t, respectively. The calculation result is shown in Figure 3 below:

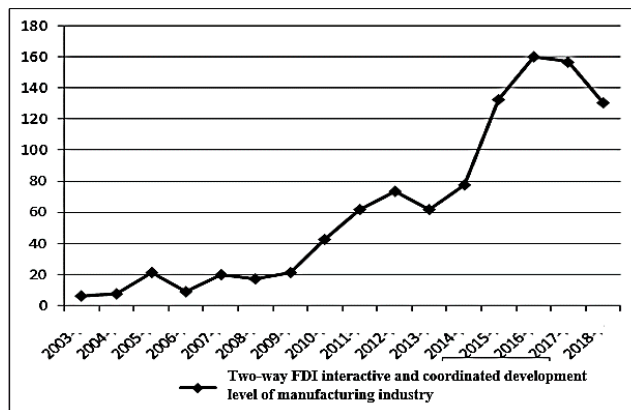


Figure:3 interactive and coordinated development level of two-way FDI in manufacturing industry, Source: calculated and collated according to the two-way FDI flow data of manufacturing industry

As can be seen from Figure 3, the level of interactive and coordinated development of China's manufacturing industry has been on the rise. From 2003 to 2012, the level of interactive and coordinated development between IFDI and OFDI in China's manufacturing industry has been rising, but both are lower than 100, indicating that the level of interactive and coordinated development of IFDI and OFDI in China's manufacturing industry is relatively low. The reason is that after the reform and opening up, China's manufacturing industry has implemented a large number of preferential tax policies to attract IFDI, while strict restrictive measures have been taken on OFDI, resulting in the uncoordinated development of IFDI and OFDI in China. However, one belt, one road initiative was launched in 2013. China actively encouraged the "going out" and "import" combination of manufacturing industries. The level of IFDI OFDI interaction and coordinated development in China's manufacturing industry correspondingly increased rapidly, and exceeded 100 in 2015, achieving a high level of coordinated development between IFDI and OFDI. From 2015 to 2018, the level of interactive and coordinated development of China's manufacturing industry has a downward trend. The reason is that IFDI of China's manufacturing industry has a large downward trend in recent years, while OFDI of manufacturing industry has developed rapidly. From 2015 to 2018, the level of interactive and coordinated development of China's manufacturing industry is still higher than 100, and the coordination level is relatively high.

2.4. GVC participation and GVC status in manufacturing industry

Under the background of the rapid development of intermediate trade, the traditional method to calculate the industrial trade income and global status by using the total export volume greatly overestimates the industrial trade income and global status. An intermediate product may be processed by several countries to become the final product. The traditional method of calculating the total export volume does not exclude the value of intermediate goods from other countries, so it will greatly overestimate the industrial trade income and global status. Koopman (2014)

[13] divides the total export value of an industry into five parts, namely, (i) the importing country uses it as the final product, (ii) the importing country uses the intermediate product to produce its domestic products, (iii) the importing country uses the intermediate product to process and export to a third country (iv) The domestic value-added and (v) foreign value-added that the importing country imports and then returns to the exporting country. According to this classification, the widely used formula (2) for calculating GVC participation and the formula (3) for GVC status are proposed:

$$GVC_PATICIPATION_{it} = \frac{IV_{it}}{EV_{it}} + \frac{FV_{it}}{EV_{it}} \quad (2)$$

$$GVC_POSITION_{it} = \ln\left(\frac{IV_{it}}{EV_{it}} + 1\right) - \ln\left(\frac{FV_{it}}{EV_{it}} + 1\right) \quad (3)$$

Among them, $GVC_PATICIPATION_{it}$ represents the GVC participation of the I industry in the T year. The higher the value is, the higher the GVC participation is, and vice versa. $GVC_POSITION_{it}$ represents the GVC status of the I industry in the T year. The larger the value, it means that the I industry exports more intermediate products to other countries than imports intermediate products from other countries for assembly and processing. Therefore, the higher the GVC status is, the lower the GVC status is. $EV_{it}, IV_{it}, FV_{it}$ represents the total export volume of the I industry in the T year, the domestic added value of the import country in the total export volume and then exported to the third country after processing the intermediate products, and the foreign added value in the total export volume. Based on the above formula, this paper calculates the GVC participation and GVC status of China's manufacturing industry from 2000 to 2014.

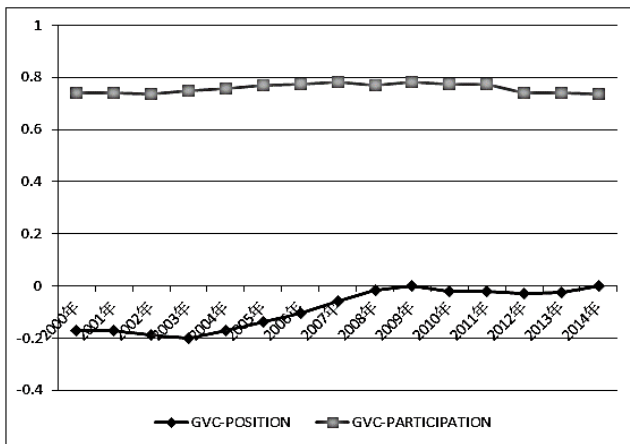


Figure 4 GVC participation and GVC status in manufacturing industry

As can be seen from Figure 4, the overall GVC participation of China's manufacturing industry was at a relatively high level of about 0.7 from 2001 to 2014. It shows that China's manufacturing industry actively participates in GVC division of labor. However, from 2000 to 2013, the GVC status of China's manufacturing industry has been in a negative number, indicating that China's manufacturing industry as a whole is in a low position of GVC, which is consistent with the current situation of "low-end locking" of GVC faced by China's

manufacturing industry. There are two reasons for the low status of GVC in China's manufacturing industry. Firstly, China's manufacturing industry participates in GVC division of labor through a large number of FDI, so GVC participation has been very high. However, most of the FDI introduced by China's manufacturing industry is labor-intensive industry. For a long time, China's manufacturing industry has been locked in the low-end position of GVC due to the long-term use of labor-rich comparative advantage to engage in product assembly and processing. Secondly, the OFDI of manufacturing industry in China is mostly pursuing the market or resources of the host country, while the OFDI pursuing the technology of the host country is less. The low status of GVC in China's manufacturing industry is just the fact that China's manufacturing industry is large but not strong. From 2000 to 2014, the position of GVC of China's manufacturing industry has been on the rising trend. In 2014, it broke through the negative value for the first time, but the value is still very low, which shows that the overall international competitiveness of China's manufacturing industry still has a lot of room for improvement.

3. The influence mechanism of IFDI, OFDI and bidirectional IFDI on GVC upgrading of China's manufacturing industry

Many theories and practices have shown that both IFDI and OFDI have a significant impact on the upgrading of GVC in China's manufacturing industry. What is the impact of IFDI, OFDI and bidirectional OFDI on GVC of China's manufacturing industry? What are the paths of these impacts? These are the problems to be discussed in this part.

3.1. Impact of IFDI on GVC upgrading of China's manufacturing industry

3.1.1. The positive impact of IFDI on GVC upgrading of China's manufacturing industry

(i) Capital supply effect

In the process of continuous development, China's manufacturing industry will inevitably encounter Savings Gap and foreign exchange gap (i.e. "double gap"). The emergence of "double gap" will hinder the development and upgrading of China's manufacturing industry. The reason is that the saving gap makes it difficult for China's manufacturing industry to obtain all kinds of domestic resources needed for production, and the foreign exchange gap makes it difficult for China's manufacturing industry to import intermediate products needed for production. IFDI not only brings a lot of capital to China's manufacturing industry, but also makes up for the "double gap" of China's manufacturing industry. It also brings various advanced production equipment to China's manufacturing industry, and has a positive impact on the upgrading of GVC in China's manufacturing industry.

(ii) Positive technology spillover effect

As the foreign manufacturing enterprises with advanced technology into China's production will produce demonstration and imitation effect on China's manufacturing industry, that is, China's manufacturing industry will imitate the advanced production technology and management experience of foreign enterprises, so as to improve their own technology and management level. In addition, when foreign enterprises enter China's manufacturing industry, they will recruit employees of China's manufacturing industry and carry out relevant skills training. Due to the mobility of personnel, country's manufacturing enterprises can also attract talents trained by foreign enterprises with high salary, so as to improve the skill level of China's manufacturing labor force. Finally, in order to reduce transportation costs and maximize profits, the intermediate products needed by foreign-invested enterprises entering China's manufacturing industry are often purchased in China. In order to ensure that the intermediate products purchased from China meet the quality requirements of their products, foreign-invested enterprises will provide production technology training for the manufacturing industries that provide intermediate products in China. IFDI can promote the GVC upgrading of China's manufacturing industry through the positive technology spillover effects of demonstration imitation, talent flow and industrial linkage.

3.1.2. The negative impact of IFDI on GVC upgrading of China's manufacturing industry

(i) "Low end locking effect"

The IFDI of China's manufacturing industry is concentrated in labor-intensive industries. A large number of labor-intensive FDI will lead to repeated construction of low-end industries, waste of resources and capital surplus. Moreover, after the introduction of labor-intensive IFDI, Chinese manufacturing enterprises are generally engaged in low-tech and low-value-added assembly work, so they are locked in the low-end position of GVC.

(ii) "Crowding out effect"

With advanced technology, advanced management experience and well-known brands, foreign-funded enterprises will seize the market of China's undeveloped manufacturing industry and produce crowding out effect on some manufacturing enterprises with development prospects in China. By virtue of various monopoly advantages, foreign enterprises will also seize the production and development resources of China's manufacturing industry, which is not conducive to the upgrading of GVC in China's manufacturing industry.

3.2. Impact of OFDI on GVC upgrading of China's manufacturing industry

3.2.1. The positive impact of OFDI on GVC upgrading of China's manufacturing industry

(i) Marginal industry transfer effect

Through OFDI, China can transfer some manufacturing industries that no longer have comparative advantages, so as to concentrate resources to build manufacturing industries with comparative advantages and realize the optimal allocation of resources. The profits from OFDI can be invested in the R & D activities of domestic manufacturing industry, which can improve the innovation ability of China's manufacturing industry and enhance the position of GVC.

(ii) Reverse technology spillover effect

China's manufacturing industry can carry out OFDI on the manufacturing industry of developed countries through green space investment, cross-border M & A, etc. Germany, Japan, the United States and other developed countries have advanced production technology. China's manufacturing industry can obtain reverse spillover of their production technology by OFDI to these developed countries. After OFDI technology reverse spillover in developed countries, China's manufacturing industry can transfer technology back to China's home country companies, promote the improvement of manufacturing technology level in China's home country, so as to enhance the GVC status of China's manufacturing industry.

3.2.2. The negative impact of OFDI on GVC upgrading of China's manufacturing industry

(i) Industrial Hollowing effect.

China's manufacturing industry OFDI needs to invest a lot of capital, which will transfer the construction resources of domestic manufacturing industry to OFDI construction, resulting in the lack of construction resources of domestic manufacturing industry and the risk of "industry hollowing out". Therefore, excessive OFDI will lead to hollowing out of China's manufacturing industry, thus hindering the upgrading of manufacturing industry GVC.

3.3. The impact of the interactive development of two-way FDI on the upgrading of GVC in China's manufacturing industry

3.3.1. Two-way technology spillover effect.

IFDI of China's manufacturing industry can produce positive technology spillover effect through demonstration imitation, talent flow and industrial linkage, and promote the upgrading of GVC in China's manufacturing industry. China's manufacturing industry is able to carry out more OFDI through IFDI. OFDI can make China's manufacturing industry obtain reverse technology spillover and promote GVC further upgrading. Therefore, the interactive and coordinated development of two-way FDI in manufacturing industry can make China's manufacturing industry obtain two-way technology spillover. Undoubtedly, the two-way technology spillover

can promote the GVC upgrading of China's manufacturing industry more than one-way technology spillover.

3.3.2. Low end locking and breakthrough effect.

A large number of labor-intensive IFDI will make China's manufacturing industry face repeated construction, waste of resources, capital surplus and other problems, and will be locked in the low-end position of GVC. Through OFDI, China's manufacturing industry can transfer the low-end manufacturing industry which is repeatedly constructed by IFDI, concentrate resources to build domestic manufacturing industry which has comparative advantage. At the same time, the profits from OFDI of manufacturing industry can be invested into R & D activities of domestic manufacturing industry, so as to improve the technical level of domestic manufacturing industry, realize "low-end breakthrough", and climb to the upstream position of GVC.

To prevent the effect of "industry hollowing out", If China's manufacturing industry carries out too much OFDI, it will transfer the construction resources of domestic manufacturing industry and lead to the "hollowing out" of manufacturing industry. IFDI of manufacturing industry can bring a lot of construction resources such as capital and equipment to our country, which makes up for the loss of resources caused by OFDI of China's manufacturing industry, so as to prevent the "hollowing out" of China's manufacturing industry. The negative impact of OFDI in China's manufacturing industry is offset by the positive impact of IFDI.

To sum up, the paper believes that the interactive and coordinated development of two-way FDI can promote the upgrading of GVC in China's manufacturing industry.

4. The empirical process of two-way FDI to upgrade GVC of China's manufacturing industry

Through the previous theoretical analysis, IFDI, OFDI and two-way FDI can have a complex impact on the GVC status of China's manufacturing industry through a variety of paths. So, what is the impact of IFDI, OFDI and two-way FDI on GVC upgrading of China's manufacturing industry? In order to solve this problem, this paper uses the data of 12 sub industries in China's manufacturing industry from 2007 to 2014 based on the data of WIOD database (the latest data is only updated to 2014), and establishes the panel fixed effect model to empirically analyze the impact of IFDI, OFDI and two-way FDI on the promotion of GVC status of China's manufacturing industry.

4.1. Model building

4.1.1. Model setting

In order to study the impact of IFDI, OFDI and two-way FDI interaction on the promotion of GVC status of China's

manufacturing industry, this paper selects the GVC status of manufacturing industry as the explanatory variable to measure the upgrading of manufacturing GVC. IFDI, OFDI and their interaction are used as explanatory variables, while R & D and human capital (HUM) are used as control variables. In order to eliminate the influence of possible heteroscedasticity of variables, the following models were constructed after taking logarithm of relevant variables

$$\text{LnGVC_POSITION}_{it} = \alpha_0 + \alpha_1 \text{LnIFDI}_{it} + \alpha_2 \text{LnOFDI}_{it} + \alpha_3 \text{LnIFDI}_{it} * \text{LnOFDI}_{it} + \alpha_4 \text{LnR\&D}_{it} + \alpha_5 \text{LnHUM}_{it} + \varepsilon_{it} \quad (4)$$

In formula (4), ε_{it} stands for random error, GVC_POSITION_{it} represents the GVC status of manufacturing industry segment i in year t , IFDI_{it} stands for foreign capital of manufacturing sector i in year t , OFDI_{it} represents the outward direct investment amount of manufacturing industry segment i in year t , $\text{LnIFDI}_{it} * \text{LnOFDI}_{it}$ represents the two-way FDI interaction of manufacturing sector i in the t year. LnR\&D_{it} represents R & D internal expenditure of manufacturing industry segment i in year t , HUM_{it} The human capital level of IT manufacturing industry i in the t year.

4.1.2. Variable selection description and data source

(i) Explained variable

The GVC status of manufacturing industry is regarded as the explanatory variable of the article. The selection basis and calculation method have been introduced in detail before, and will not be repeated here. The data are from WIOD world input-output database.

(ii) Explanatory variables

According to the above analysis, IFDI can affect the GVC status of China's manufacturing industry through a variety of ways, so this paper sets IFDI of manufacturing industry as an explanatory variable. This paper uses the foreign capital of each subdivision of manufacturing industry to measure. The relevant data in "China Industrial Statistical Yearbook" are used.

According to the above analysis, OFDI can affect the GVC status of China's manufacturing industry through a variety of ways, so this paper sets OFDI of manufacturing industry as the explanatory variable. Due to the lack of data on manufacturing industry segments in China's foreign direct investment bulletin, this paper uses Xie Yan's (2019) [14] for reference, and uses the product of the proportion of industrial sales value of each manufacturing industry segment in the total industrial sales value of manufacturing industry and the foreign direct investment amount of each manufacturing industry segment. The relevant data in China Industrial Statistics Yearbook and China's foreign direct investment bulletin are used for data.

FDI subdivides for manufacturing industry in two directions. According to the above analysis, the

interaction of two-way FDI can affect the GVC status of China's manufacturing industry through a variety of ways. Therefore, this paper takes the bidirectional FDI of manufacturing industry as the explanatory variable. The logarithm of IFDI flow in manufacturing industry is multiplied by logarithm of OFDI flow in manufacturing industry. The data are from China Industrial Statistics Yearbook and China's foreign direct investment bulletin.

(iii) Control variable

Research and Development (R & D) intensity is the essence of innovation. Investment in R & D can improve the innovation ability of the industry, that is to say, improve the level of production technology. The improvement of industry production technology level enables enterprises to engage in the high-tech stage of product production, so as to enhance the position of the industry in GVC. Therefore, this paper takes the R & D intensity of manufacturing industry as the control variable. It is expressed by internal R & D expenditure of manufacturing industry. The data are from China Science and technology statistical yearbook.

Human capital level (HUM), The theory of human capital shows that the richer the human capital is, the more likely it is to develop high-tech products. Therefore, the level of human capital has an important impact on the GVC status of an industry. This paper uses the proportion of R & D personnel in the manufacturing industry in the total number of employees. The data are from China Science and technology statistical yearbook.

4.1.3. Descriptive statistics of variables

According to the model set above, the descriptive statistical results of each variable are shown in Table 1

Table 1 descriptive statistics of each variable

Variable	sample size	average	standard deviation	maximum	minimum
LNGVC_POS	96	-0.030755	0.034805	0.061262	-0.117463
LNIFDI	96	6.409030	1.062252	8.087667	3.823541
LNOFDI	96	0.913463	0.967915	2.450638	-1.496755
LNIFDI*LNOFDI	96	6.396219	6.524274	17.11934	-6.705307
LN&D	96	8.255777	2.439046	14.56982	3.765840
LNHUM	96	-0.829754	0.728103	0.201969	-3.340709

Note: calculated according to evIEWS10

4.2. Empirical test

(i) Unit root test

Before sample regression, unit root test should be carried out for each variable to prevent pseudo regression. It can be seen from the test results in Table 2 below that after the second-order difference, all variables are at the significance level of 1% or 5%. According to ADF Fisher and LLC experience, all variables are stationary after second-order difference.

Table 2 Unit Root Test results

Variable	LLC Test	Conclusion	ADF-Fisher Test	Conclusion
Δ^2 LNGVC	-14.9745 (0.0000) ***	stable	38.3272 (0.0321) **	stable
Δ^2 LNIFDI	-13.3192 (0.0000) ***	stable	50.1468 (0.0014) ***	stable

Δ^2 LNOFDI	3.54576 (0.009) ***	stable	3.80190 (0.001) ***	stable
Δ^2 LNIFDI*LNOFDI	2.04039 (0.007) ***	stable	6.28269 (0.008) ***	stable
Δ^2 LN&D	-18.0706 (0.0000) ***	stable	39.7853 (0.0225) **	stable
Δ^2 LNHUM	-24.7245 (0.0000) ***	stable	66.3324 (0.0000) ***	stable

Note: according to the calculation by evIEWS10, the Δ is the quadratic difference of the variable

(ii) Cointegration test

From the above unit root test, we can know that each variable is a second-order single integration, and we can carry out cointegration test. According to the test results in Table 3 below, the corresponding p value of ADF statistic is 0.0011, that is, it passes the KAO test at the significance level of 1%. Therefore, there is a long-term equilibrium cointegration relationship among the variables, which can be used for sample regression.

Table 3 KAO test results

Inspection form	Statistic	P Value
ADF	-3.074266	0.0011

Note: calculated according to evIEWS10

(iii) Model selection

In this paper, Hausman test is used to determine whether the fixed or random effect model is adopted. According to the test results in Table 4, P value is 0.0068. At the significant level of 1%, the original hypothesis of random effect model is rejected and fixed effect model is selected.

Table 4 Hausman test results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	16.026443	5	0.0068

Note: calculated according to evIEWS10

4.3. Empirical results and analysis

This paper uses evIEWS10 econometric software to conduct empirical analysis according to the fixed effect model. The results are shown in Table 5.

Table 5 regression results

Variable	Model Results
LnIFDIit	-0.019656** (-2.544546)
LnOFDIit	0.049828*** (3.287090)
LnIFDIit*LnOFDIit	0.006980*** (3.034072)
LnR&Dit	0.005798*** (3.583055)
LnHUMit	0.003117*** (2.288121)
Constant	0.045635*** (0.908568)
Sample Size	96
Adjusted R2	0.854331

Note: according to the calculation of $eviews10$, the data above the bracket represents the regression coefficient, the data in the bracket represents the t statistic, and *, **, and ** represent the significance levels of 1%, 5% and 10% respectively.

The regression equation can be obtained from Table 5

$$\begin{aligned} \text{LnGVC_POSITION}_{it} = & 0.045635 + \\ & -0.019656\text{LnIFDI}_{it} + 0.049828\text{LnOFDI}_{it} + \\ & 0.006980\text{LnIFDI}_{it} * \text{LnOFDI}_{it} + 0.005798\text{LnR\&D}_{it} + \\ & 0.003117\text{LnHUM}_{it} \end{aligned} \quad (5)$$

According to formula (5), the explanatory variable IFDI is significant at the level of 5%, and the coefficient is negative. Every 1% increase of IFDI will reduce the GVC status of China's manufacturing industry by 0.019656%, which indicates that IFDI will have a negative impact on the upgrading of manufacturing GVC in China, which is consistent with the current situation that China's manufacturing industry faces the dilemma of "low-end lock-in" caused by the massive introduction of labor-intensive IFDI in China's manufacturing industry. The explanatory variable OFDI is significant at the level of 1%, and the coefficient is positive. For every 1% increase of OFDI, the GVC status of China's manufacturing industry will increase by 0.049828%. The main reason is that China's manufacturing industry actively obtains foreign high-tech to upgrade GVC through OFDI. The explanatory variable $\text{LnIFDI} * \text{LnOFDI}$ is significant at the level of 1%, and the coefficient is positive. When the two-way FDI increases by 1%, the GVC status of China's manufacturing industry will increase by 0.006980%, which indicates that the coordinated development of two-way FDI in manufacturing industry can promote the upgrading of manufacturing GVC in China, which can be coordinated with the above analysis of two-way FDI in manufacturing industry, which can be achieved through two-way technology spillover effect, low-end lock-in and breakthrough, and prevent industrial vacancy. The conclusion that the cardioversion effect promotes the upgrading of GVC in China's manufacturing industry is consistent. The control variables R & D and HUM are significant at the level of 1%, and the coefficients are all positive. With the increase of R & D and HUM, the GVC status of China's manufacturing industry will increase by 0.005798% and 0.003117% respectively, indicating that the internal R & D expenditure and the increase of scientific and technological personnel can promote the upgrading of GVC in China's manufacturing industry.

5. Conclusion and Suggestions

The participation of GVC in China's manufacturing industry is very high, but its GVC status is very low. Manufacturing industry is the leading industry in China's national economy. Improving the GVC status of manufacturing industry is conducive to improving China's overall international competitiveness. Therefore, it is an urgent task to improve the GVC status of China's manufacturing industry. Based on the above empirical analysis, this paper puts forward the following

suggestions to promote the upgrading of GVC in China's manufacturing industry

5.1. Improving the quality of FDI in manufacturing industry

Since the reform and opening up for more than 40 years, China's manufacturing industry has been integrated into the GVC dominated by developed countries by introducing a large number of FDI. However, most of the FDI introduced by China's manufacturing industry is labor-intensive, mostly engaged in the assembly and processing of products, which has been locked in the low-end of GVC for a long time. Therefore, on the one hand, China's manufacturing industry should introduce more high-tech intensive FDI, such as medical machinery and equipment. This year, novel coronavirus pneumonia has occurred in many countries around the world. China has imported some expensive ECMO medical equipment to treat some new severe cases of severe pneumonia. China lacks the manufacturing industry of high-end medical devices such as ECMO. Therefore, country should introduce more high-end medical device manufacturing FDI to obtain positive technology spillover. The introduction of high-tech intensive FDI into China's manufacturing industry, such as medical devices and electronic equipment, can improve China's ability to resist risks and improve the production level of China's manufacturing industry, so as to improve the position of China's manufacturing industry in GVC. On the other hand, China's manufacturing industry should strengthen the environmental quality supervision of manufacturing IFDI, and ban those manufacturing IFDI that pollute China's environment. Only the environment-friendly manufacturing IFDI can promote the long-term development of China's manufacturing industry and upgrade GVC.

5.2. Encourage manufacturing industry to carry out more OFDI

In 2013, BELT and ROAD INITIATIVE (BRI) was proposed to encourage Chinese enterprises to "go global". Practice has proved that the "Belt and Road" initiative has achieved a win-win situation for China and the "Belt and Road" countries; not only brings a lot of jobs to the "Belt and Road" countries, but also promotes their economic growth, and transfers excess production capacity in China's manufacturing industry. Such initiative promotes industrial transformation and upgrading. Therefore, China should encourage the manufacturing industry to further expand OFDI, transfer manufacturing industries that do not have comparative advantages through OFDI, and concentrate resources on the development of domestic manufacturing industries that still have comparative advantages. The profits from OFDI can also be used for R & D activities of domestic manufacturing industry to improve the production technology level of domestic manufacturing industry, so as to improve the GVC status of China's manufacturing industry. According to the foreign investment Bulletin of 2018, the manufacturing

industry that carries out the most OFDI in China is the automobile manufacturing industry, while the number of OFDI conducted by the pharmaceutical manufacturing industry is four times less than that of the automobile manufacturing industry. The emergence of the novel coronavirus pneumonia has infected tens of thousands of people in China. The key to treating these patients is to develop corresponding drugs. Only relying on the technical level of a country in China can develop drugs to treat new coronavirus, but it will take a long time. Therefore, China should strengthen OFDI of pharmaceutical manufacturing industry to obtain reverse technology spillover of other countries' pharmaceutical manufacturing industry, so as to improve the technical level of China's pharmaceutical manufacturing industry and shorten the time for developing anti-virus drugs. The pharmaceutical manufacturing industry is a high-tech intensive manufacturing industry. Increasing OFDI in China's pharmaceutical manufacturing industry can not only speed up the production of anti-virus drugs in China, but also improve the GVC status of China's manufacturing industry. At present, China's manufacturing OFDI to developed countries only accounts for 20% of the total OFDI of China's manufacturing industry. Therefore, China should encourage more manufacturing enterprises to expand OFDI to the manufacturing industry of developed countries and obtain the reverse spillover of advanced technology in the manufacturing industry of developed countries, so as to realize the upgrading of manufacturing industry GVC.

5.3. Promoting the coordinated development of two-way FDI in manufacturing industry

Through the previous analysis, it is concluded that one-way IFDI or one-way OFDI will have positive and negative effects on the upgrading of GVC in China's manufacturing industry, and the coordinated development of two-way FDI can promote the upgrading of GVC in China's manufacturing industry. Therefore, China should promote the coordinated development of two-way FDI in manufacturing industry and realize the upgrading of manufacturing industry GVC. According to the above calculation, we can know that the level of interactive and coordinated development of China's manufacturing industry is getting higher and higher, which is mainly due to the implementation of the policy of encouraging enterprises to "bring in" and "go out". However, according to the statistical data of 2018, OFDI flow of manufacturing industry is about 1.15 times less than IFDI flow of manufacturing industry. This shows that there is a big gap in the development level of two-way FDI in China's manufacturing industry. Therefore, the state should vigorously encourage the manufacturing industry to carry out OFDI, such as providing certain direct investment fund support to the "going out" manufacturing industry, promoting the coordinated development of two-way FDI of manufacturing industry, and improving the status of GVC. In the process of fighting against the new coronavirus in our country, there have been a shortage of protective medical materials such as medical masks and

eye protection clothing. Therefore, China should strengthen the OFDI of medical materials manufacturing industry. In the event of an outbreak in China, we can quickly import medical materials from the subsidiaries located in the host country, so as to alleviate the shortage of medical materials needed for fighting against the epidemic situation in China. In addition, China's laws and regulations on IFDI of manufacturing industry have been relatively perfect, while the laws and regulations on OFDI of manufacturing industry are less. Therefore, China should also improve the OFDI laws of manufacturing industry, guide manufacturing enterprises to carry out OFDI reasonably, and promote the coordinated development of two-way FDI laws in China's manufacturing industry, so as to promote the upgrading of GVC in China's manufacturing industry.

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