

Research on the industrial upgrading effect of China's outward foreign direct investment on equipment manufacturing industry

Chen Shaogui

Department of Economics, Central University of Finance and Economics, China

Received: 09 Nov 2020; Received in revised form: 14 Dec 2020; Accepted: 21 Dec 2020; Available online: 31 Dec 2020

©2020 The Author(s). Published by Infogain Publication. This is an open access article under the CC BY license

(<https://creativecommons.org/licenses/by/4.0/>).

Abstract— Based on the panel data of 30 provinces in China (excluding Tibet) from 2004 to 2017, this paper uses a two-way fixed effect stepwise regression model to analyze the impact of China's outward foreign direct investment on the high-end rate of equipment manufacturing industry, and empirically studies the effect of China's outward foreign direct investment on the upgrading of equipment manufacturing industry. The empirical results show that: China's outward foreign direct investment has a significant impact on the upgrading of high-end equipment manufacturing industry. From the regional level, the northeastern region has the most significant positive impact, followed by the eastern region, the central region has a negative impact, and the western region has no obvious impact. Finally, this paper puts forward corresponding countermeasures and suggestions on how to use outward foreign direct investment to promote the upgrading of equipment manufacturing industry.

Keywords— outward foreign direct investment, equipment manufacturing industry, high end, industrial upgrading.

I. INTRODUCTION

At present, although the trend of anti globalization is surging in Europe and the United States, economic globalization is still the mainstream of global economic development, and international capital flow is still the main factor driving economic globalization. With China's entry into a new round of reform and opening up, China's foreign direct investment continues to maintain a rapid growth momentum. According to the statistical bulletin of China's foreign direct investment, from the perspective of two-way investment, China's OFDI exceeded the actual foreign investment (FDI) in the same year for four consecutive years from 2015 to 2018, and China has begun to become a net capital exporter. Especially in recent years, China has been ranked in the top three of the world's foreign direct investment flow for seven consecutive years, and China's foreign direct investment has become a booster of world economic growth. According to the theory and practice of foreign direct investment, foreign direct investment will certainly bring important influence to the industry of home country, such as resource

allocation effect, industrial upgrading effect, reverse technology spillover effect, technological progress effect, etc. From the current situation of China's manufacturing industry development, due to the limited international division of labor pattern of global manufacturing industry, China's manufacturing industry, especially the equipment manufacturing industry, has been in the "low-end locking" position in the global value chain for a long time. It is urgent to accelerate the transformation and upgrading of the equipment manufacturing industry and enhance international competition through foreign direct investment, overall utilization of international resources and markets to promote the equipment manufacturing industry to the high end of the global value chain. Therefore, it is very important to study the industrial upgrading effect of China's foreign direct investment on the equipment manufacturing industry.

II. LITERATURE REVIEW

With regard to the definition of OFDI, the International Monetary Fund (IMF) believes that OFDI refers to an

investment activity in which a country is engaged in production and operation abroad and obtains continuous income. Its main purpose is to have the management power of overseas enterprises.^[1] The OECD points out that the so-called outward foreign direct investment refers to the investment activities that can gain economic benefits and effectively control them by establishing long-term strategic cooperative relations with enterprises in other countries.^[2] According to the Ministry of Commerce of China, outward foreign direct investment is an economic activity in which domestic investors establish and purchase overseas enterprises in the form of physical objects, cash or intangible assets in Hong Kong, Macao and Taiwan, and control 10% and above equity of the enterprise and control its operation and management rights.^[3] This paper mainly refers to the formulation of the Ministry of Commerce of China, and holds that outward foreign direct investment is the behavior of multinational enterprises to invest in cash, material objects and intangible assets in order to gain effective control over the operation and management of foreign enterprises.

Foreign scholars have studied the meaning of industrial upgrading earlier. Porter (1990) first introduced the concept of "industrial upgrading" in the global value chain, believing that industrial upgrading is a process in which the production efficiency, production quality and profitability of enterprises in the industrial chain continue to improve^[4]. According to Gereffi (1999), industrial upgrading is a process in which manufacturing enterprises gradually climb to the high-end value-added link in the global value chain^[5]. Ernst (1998) classified industrial upgrading into five parts: inter industry upgrading, inter factor upgrading, demand upgrading, function upgrading and chain upgrading^[6]. According to Poon, the process of transferring products produced by enterprises from low added value to high added value is industrial upgrading^[7]. The time when domestic scholars put forward the concept of "industrial upgrading" is similar to that of foreign scholars. Li Hongji (1987) and Wu Chongbo (1988) first proposed the concept of "industrial upgrading". However, most of the domestic explanations of "industrial upgrading" before this were still at the macro level of "industrial restructuring", mainly focusing on the adjustment and optimization of the proportion of China's three industries. After the concept of "industrial upgrading" was put forward, it soon affected the whole academic circle in China. Domestic scholars studied from different perspectives, such as the adjustment of industrial structure, the use efficiency of factor endowment, product upgrading, value chain upgrading, and the improvement of industrial quality and efficiency. The conclusion is quite

similar to that of foreign scholars. Based on the views of scholars at home and abroad, this paper holds that industrial upgrading is a process of continuously improving the added value of products through the optimization of factor allocation, structural adjustment, efficiency improvement, quality improvement and value chain upgrading.

As for the research on the relationship between OFDI and industrial upgrading, scholars mainly study whether OFDI has an impact on industrial upgrading, and whether the impact effect is positive or negative. Scholars at home and abroad have drawn different conclusions based on different research perspectives and methods. To sum up, there are three main types.

The first point of view: OFDI has a significant role in promoting the industrial upgrading of the home country. Most studies have shown that OFDI can promote the industrial upgrading of home countries. Adler (1974) through the study of outward foreign direct investment in South Korea, outward foreign direct investment can improve the added value of enterprise products, but also can promote the upgrading of home country industry^[8]. Kojima (1978) first analyzed the connotation of "marginal industry expansion theory", and discussed the internal relationship between OFDI and industrial upgrading. The main point of the theory is that through the transfer of domestic overcapacity and inferior industries to overseas, the resources will be concentrated on the development of advantageous industries, which is conducive to the optimization and upgrading of industrial structure and the healthy development of foreign trade^[9]. Blomstrom et al. (2000) took Japan as an empirical research object, explored and analyzed the internal relationship between its overseas investment and economic structure optimization, and the results showed that overseas investment was conducive to improving the efficiency of enterprise resource allocation and promoting the transfer of marginal industries in Japan^[10]. According to the research of developing countries and transition countries (regions), outward foreign investment can significantly enhance the industrial competitiveness of developing countries, and show significant technology spillover effect and correlation effect, which can significantly improve the overall development level and competitive advantage of related industries^[11]. Rossel (2000) pointed out that through the overseas transfer of low-end industries, South Korea realized the concentration of production resources to domestic advantageous industries through the overseas transfer of low-end industries, which significantly improved the technical level of domestic industries and

provided a significant driving force for industrial upgrading ^[12].

Based on domestic empirical data, domestic scholars also study and analyze the impact of China's OFDI on industrial upgrading. Yang Dakai (2003) believes that high-tech enterprises can not only effectively utilize the local human capital elements, but also improve the technical level and management experience of enterprises by making outward foreign direct investment in technology or knowledge intensive countries and regions, so as to reverse promote the technological progress of the home country and have a positive impact on the industrial upgrading of the home country. Gao Lifeng et al. (2013) also reached the same conclusion through the analysis of the relationship between foreign direct investment and industrial upgrading in the United States from 1966 to 2010. At the same time, he also pointed out that the outward investment of manufacturing, wholesale and retail industry, and oil industry had the most obvious effect on industrial upgrading ^[13]. Zhang Yuanpeng and Li Yujie (2014) believe that the larger the scale of China's outward foreign direct investment, the better the efficiency of industrial structure upgrading. Outward foreign direct investment in high-tech industries has significantly affected the optimization level of domestic industrial structure ^[14]. The empirical research results of Li Dongkun and Deng Min (2016) pointed out that China's overseas investment has a significant spillover effect, and the increase of outward foreign direct investment is conducive to improving the level of industrial structure, and can also significantly improve the rationality of industrial structure of related industries and neighboring regions ^[15].

The second view is that OFDI has no significant effect on industrial upgrading of home country. A few scholars believe that the promotion of OFDI on the optimization of industrial structure of home country is not significant, or even does not exist. Pan Sukun and Yuan Ran (2014) divided the 58 host countries of China's outward direct investment from 2003 to 2012 into three groups: resource seeking, market seeking and technology seeking. Through empirical analysis of relevant data, it is found that OFDI with three different motives has no significant effect on China's industrial optimization. Yang Ying and Liu Caixia's (2015) research based on VAR model shows that there is a one-way promotion effect between the two, that is, the adjustment of industrial structure can promote the expansion of OFDI scale, but the effect of OFDI on the industrial adjustment of home country has not yet appeared. The calculation results of Zhang Yuanpeng and Li Yujie (2014) show that the correlation degree between them is only 0.73, which means that the promotion effect

of OFDI on industrial optimization is relatively weak. This is related to the late start and small scale of China's outward foreign direct investment, as well as the deep foundation of domestic traditional industries and the imperfection of domestic supporting facilities, resulting in the effect of promoting the optimization of industrial structure is not obvious.

The third point of view: outward foreign direct investment hinders the industrial upgrading of the home country. There are also many arguments about whether OFDI will hinder the industrial upgrading of home countries. Some of them think that OFDI brings hollowing out of the home country's industry, which will lead to the decline of the related industries in the home country. Qi Jianhong et al. (1996) believed that with the expansion of Japan's foreign investment scale, Japan appeared "industrial hollowing out" in the mid-1980s. Among them, the flow of investment, speed, industry type and other factors determine the size of the negative effect of outward foreign investment on industrial upgrading ^[16]. Shi Liu et al. (2013) ^[17] and Wang Rong et al. (2015) ^[18] respectively studied outward foreign direct investment and industrial "hollowing out" from the perspective of Guangdong Province and Yangtze River Delta region, and concluded that although outward foreign direct investment does not lead to the hollowing out of equipment manufacturing industry in Guangdong Province and the Yangtze River Delta, with the development of outward foreign direct investment, equipment manufacturing in Guangdong Province and the Yangtze River Delta region has become increasingly prominent. It is concluded that there is a trend of "hollowing out" in the industry. In order to prevent "hollowing out" of industries, Sang Baichuan et al. (2016) put forward the principle of "grasping both ends and opening up the middle" in outward foreign direct investment on the basis of analyzing the experiences and lessons of outward foreign direct investment of the United Kingdom, the United States and Japan ^[19].

To sum up, a large number of domestic and foreign literature on the relationship between outward foreign direct investment and industrial upgrading, mainly concentrated on the macro level, most of which are about the impact of outward foreign direct investment on the optimization and upgrading of the three industrial structure, while the analysis of a specific industry or sub industry is less. From the research results, it is also relatively scattered, with different views. Generally speaking, the positive is more than the negative, and the impact is significantly more than not significant. In addition, there are few researches on the impact of OFDI

on the upgrading of equipment manufacturing industry in home country, which needs to be further strengthened.

III. ANALYSIS ON THE MECHANISM OF OFDI PROMOTING THE UPGRADING OF MANUFACTURING INDUSTRY IN HOME COUNTRY

The optimization and upgrading of an industry or industry involves many factors, including national macro industrial

policy, industry development planning and business behavior of enterprises. Based on the above literature research and analysis, this paper draws on the research results of Fang Yu (2013) ^[20], Zhu Chunlan (2017) ^[21], etc., analyzes the industrial upgrading effect of OFDI on the equipment manufacturing industry, and studies from the perspective of enterprise to industry from the micro and medium level.

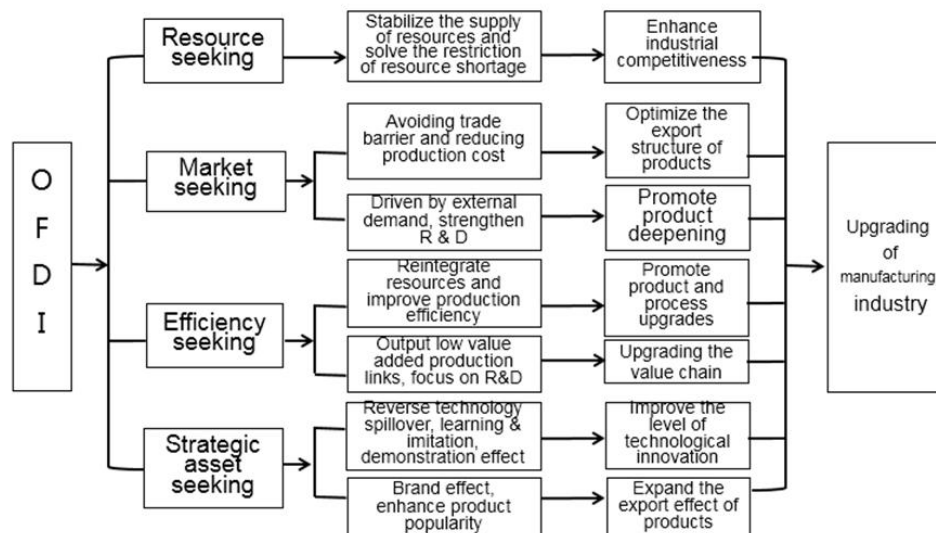


Fig.1: The impact mechanism of OFDI on the upgrading effect of manufacturing industry at the enterprise level

3.1 Enterprise level

According to the different motivations of OFDI by scholars at home and abroad, it is concluded that the OFDI behavior of enterprises can be roughly divided into four types: resource seeking, market seeking, efficiency seeking and strategic asset seeking. These four types of OFDI have different effects on the upgrading of manufacturing industry, but they have promoted the upgrading of manufacturing industry from different aspects. The mechanism is shown in Figure 1.

3.1.1 Resource seeking

Resources are the first condition to support the development of industry, and obtaining cheap resources is one of the key motivations of OFDI. Resource seeking OFDI refers to foreign investment activities in order to obtain cheap natural resources such as minerals and oil, as well as labor resources. The impact of resource seeking OFDI on the upgrading of manufacturing industry is mainly through outward foreign direct investment, establishing stable resource supply channels in the world, increasing resource supply, obtaining key resources needed for industrial development, easing the constraint

pressure on domestic resources and environment, breaking the resource bottleneck, providing resource support and guarantee for the development of manufacturing industry and improving industrial competition. At the same time, it can promote the upgrading of manufacturing industry through industrial competition effect and correlation effect.

3.1.2 Market seeking

Market seeking OFDI refers to foreign investment activities to stabilize or seize the market share of host countries, improve market share and expand overseas development space. In international trade, in order to protect domestic manufacturing industry from external shocks and improve local employment rate, countries often set up trade barriers, implement trade protectionism, and encourage foreign capital to invest in their own country. Therefore, in order to avoid trade barriers and open up overseas markets, enterprises often invest and set up factories abroad, and begin to shift from export trade to outward foreign direct investment, thus expanding overseas market share. The impact of market seeking OFDI on the upgrading of manufacturing industry is

mainly manifested in two aspects: on the one hand, outward foreign direct investment into the production and sales of the host country can not only avoid trade barriers, but also achieve scale effect and reduce production costs by expanding supply, at the same time, it can drive the output of relevant products and services, optimize the export structure of products and promote the structural adjustment of manufacturing industry. On the other hand, with the help of the host country market, enterprises can have a close relationship with the international market, understand the demand preference of foreign markets for products, track the situation of competitors in time, and drive domestic research to develop new products, new businesses and new processes, promote product deepening and realize the upgrading of manufacturing industry.

3.1.3 Efficiency seeking

Efficiency seeking OFDI refers to foreign investment activities to improve production efficiency. Generally speaking, the efficiency seeking type is higher in level and wider in scope than the resource and market seeking type mentioned above. This type of outward foreign direct investment is systematic. Enterprises carry out cross-border integrated investment through overseas subsidiaries, relying on international factor resources and market division of labor, reorganize production, sales and service in the world, so as to realize the maximization of scale economy and efficiency. The impact of efficiency seeking OFDI on the upgrading of manufacturing industry is mainly manifested in two aspects: on the one hand, enterprises rely on their own comparative advantages, re-integrate factor resources in the global scope, make use of foreign cheap resources and skilled labor, reduce the production costs of enterprises, improve the production efficiency of enterprises, enhance the international competitiveness, promote enterprises to increase revenue and reduce expenditure, and have the ability to do more research. On the other hand, in order to improve the input-output efficiency and firmly control the foreign market, enterprises export high-cost and low-value-added production or assembly links to overseas with the help of outward foreign direct investment, while leaving high-value-added R&D design and marketing service links at home, focusing on product design, technology research and development and sales services, and promoting enterprises greatly improve their efficiency level, continuously improve the ranking in the global value chain, and promote the upgrading of domestic manufacturing industry.

3.1.4 Strategic asset seeking

Strategic assets are the core competitiveness of enterprises, which are difficult to obtain in the external market. Different from the above three kinds of investment mobility, OFDI with strategic asset seeking refers to the outward direct investment activities to obtain strategic assets such as advanced technology, knowledge patent, trademark brand, management skills and sales network. Some scholars list technology acquisition OFDI separately, which also reflects the importance of advanced technology as a strategic asset. OFDI with strategic asset seeking belongs to the investment behavior of creating superior resources and improving ability. Its main goal is to help enterprises build new competitive advantages and maintain and consolidate their dominant position in the market. The impact of strategic asset seeking OFDI on the upgrading of manufacturing industry is mainly manifested in two aspects: on the one hand, through new investment or cross-border M&A, enterprises acquire advanced technology strategic assets with the help of reverse technology spillover effect of outward foreign direct investment, and help enterprises break through technical barriers through external economy, demonstration effect, learning imitation and industrial association, improve the labor production efficiency of the whole manufacturing industry and promote the upgrading of the manufacturing industry in the home country. On the other hand, the acquisition of strategic assets such as brand and marketing network helps to form the brand effect of enterprises, enhance the popularity of enterprises, broaden the sales channels, increase the export orders of enterprises, expand the export effect of products, and promote the structural adjustment and upgrading of the manufacturing industry in the home country.

3.2 Industry level

It can be seen from the previous literature that OFDI has the effect of industrial upgrading, which has been recognized by most scholars at home and abroad. To sum up, from the industrial level, as far as manufacturing industry is concerned, OFDI promotes the optimization and upgrading of manufacturing industry through industrial transfer effect, industrial correlation effect and industrial competition effect. The influence mechanism is shown in Figure 2.

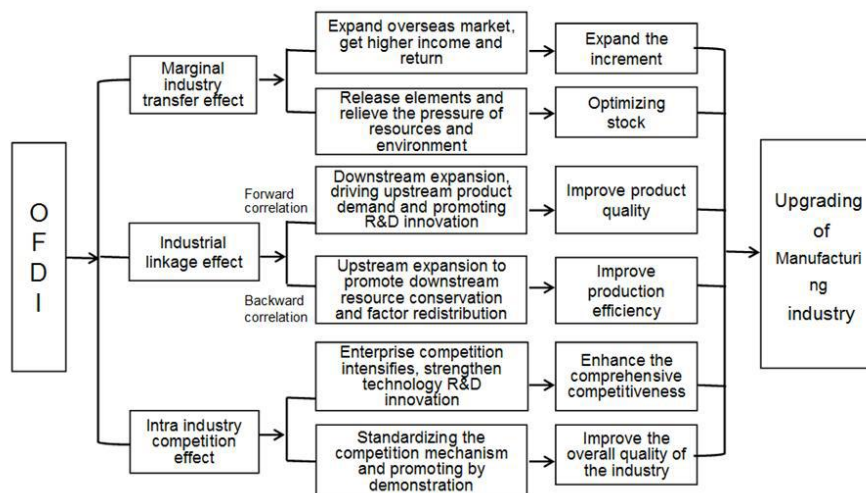


Fig.1: The impact mechanism of OFDI on the upgrading effect of manufacturing industry at the industry level

3.2.1 Marginal industry transfer effect

Kojima (1978), a Japanese economist, analyzes the mechanism of OFDI promoting industrial upgrading. The core meaning of the theory is that OFDI should be carried out in turn from the "marginal industries" of the country, that is, the industries that have been or will be in a comparative disadvantage. Generally speaking, marginal industries have dual meanings. For investment countries, they may be industries that have lost their comparative advantages in international trade, including industries with overcapacity, and industries with high energy consumption and high pollution that are incompatible with the local development environment of the home country; however, for the host country, they may be industries with comparative advantages and can extend their life cycle. The marginal industry transfer effect of OFDI on the upgrading of manufacturing industry is mainly manifested in two aspects: one is that the investment country transfers the marginal industry to the host country through OFDI. The marginal industry has a comparative advantage in the host country, which is equivalent to prolonging the time for the transferred industry to play the comparative advantage of the industry. At the same time, it can also make use of the local cheaper production factor resources to obtain the higher investment income, which can be returned to China, can also provide financial guarantee for the development of domestic emerging manufacturing industry or transformation and upgrading of traditional manufacturing industry, expand the increment of domestic manufacturing industry and promote the upgrading of manufacturing industry. Second, with the help of outward foreign direct investment, the traditional marginal industries or industries with excess capacity can be transferred to foreign countries, which can release the

capital, technology, labor force and other production factors deposited in the marginal industries. The released production factors can be transferred to the domestic emerging or comparative advantage manufacturing industries, or used to upgrade and transform other traditional advantageous manufacturing industries in China. The optimization of domestic manufacturing stock can also release more pressure on population, resources and environment, provide support for the development of these industries in terms of manpower, technology, capital and environment, and promote the upgrading of manufacturing industry.

3.2.2 Industrial linkage effect

Referring to Albert Otto Hirschman's "industrial relevance theory", this paper points out that there must be such an industry in the chain of industrial association, which has the highest correlation coefficient with its forward and backward industries in the input-output relationship. The development of this industry has a greater role in promoting the development of its forward and backward industries. In the process of OFDI, manufacturing industry will influence the industrial chain and all links of manufacturing industry through the forward and backward correlation effect between industries, so as to promote the upgrading of manufacturing industry. In the industrial chain, the upstream industry is located at the beginning of the whole industrial chain, often holding important resources, including core technology, etc., while the downstream industry refers to the end of the whole industrial chain. In the extension of the industrial chain, the extension of the industrial chain to the upstream generally makes the industrial chain enter into the basic industry link, as well

as the technology R&D design link, while the downstream expansion enters the market expansion and product service link. The impact mechanism of OFDI forward correlation effect is mainly reflected in: in the process of OFDI, downstream industries will certainly expand the overseas production scale of their industries, stimulate the product demand of upstream industries in their home countries, stimulate the scale expansion of upstream industries, and obtain economies of scale benefits. In addition, facing more fierce international market competition in OFDI, we need stronger international competitiveness to promote upstream industries to strengthen technological innovation and progress, increase technological research and development and product upgrading, and improve product quality. Through the pull relationship between the industry chain from the bottom to the up, and then promote the overall quality of the domestic manufacturing industry chain. The mechanism of OFDI backward correlation effect is mainly reflected in: upstream industries produce primary and intermediate products in the host country in the process of OFDI, and promote the conservation of domestic production factor resources. Through the promotion relationship from upstream to downstream of the industrial chain, the domestic production factors can be effectively released and reallocated, which makes the domestic downstream industries more likely to concentrate capital, technology and human capital to improve product production and R&D, and improve production efficiency. In a word, whether it is the pull of forward linkage or the promotion of backward linkage, it is conducive to the expansion of manufacturing industry chain and the upgrading of manufacturing industry.

3.2.3 Intra industry competition effect

Michael E. Porter, an American economist, has made a detailed study on the promotion of competition to industrial upgrading in his "Diamond Model" theory. According to its competition theory, an industry in a country should not only face the international competition, but also intensify the domestic competition of the industry, and eventually lead to the whole industry in the international competition. The influence mechanism of OFDI on the intra industry competition of manufacturing industry is mainly manifested in two aspects: one is to take the lead in "going out" multinational enterprises through outward foreign direct investment, and obtain intangible asset spillovers such as technology, management and brand through various forms such as active M&A and green land investment. In order to adapt to the fierce international competition, OFDI constantly carries out technology research and development to improve product competitiveness. And in the same industry in the domestic

market to obtain advantages, and occupy a favorable competitive position. This kind of enterprises bring survival competition to domestic enterprises in the same industry. In order to consolidate, maintain and expand the original competitive advantages and meet the challenges of leading multinational enterprises taking the lead in "going out", other enterprises must also increase investment in technology research and development, seek innovation and breakthrough, innovate management methods, and reduce production costs, so as to improve their comprehensive competitiveness. This kind of enterprise competition leads to intensified industry competition, improves the overall quality of the whole industry, and finally promotes the optimization and upgrading of industrial structure. The second is the introduction of standardized international market competition mechanism by multinational enterprises with outward foreign direct investment. This competition mechanism is transmitted to the domestic competitive market of the same industry, forming an intra industry demonstration competition mechanism, driving the comprehensive reform and healthy competition of domestic peers and related industries, improving the overall quality of the home country industry, and finally promoting the upgrading of the manufacturing industry.

IV. RESEARCH DESIGN AND VARIABLE SELECTION

Because the panel data model has more significant advantages that it can take into account the relationship between variables in time and space. Therefore, this paper uses the panel data of 30 provinces in China from 2004 to 2017 (due to the special characteristics of Tibet, the lack of economic data is relatively serious, which is excluded from the samples of empirical analysis; in addition, some missing data are supplemented by means of mean filling method), and further analyzes the industrial upgrading effect of OFDI on the equipment manufacturing industry of each province in China.

4.1 Variable selection and data source

4.1.1 Explained variables

The explained variable is the high-end rate of equipment manufacturing industry (HRE), which is the ratio of the total industrial output value of advanced equipment manufacturing industry and manufacturing industry, and is an important indicator to measure the upgrading effect of equipment manufacturing industry. This paper assumes that the upgrading effect of equipment manufacturing industry is reflected in the rationalization and coordination of industrial structure and the high-end of industrial structure. The advanced equipment manufacturing industry

has been constantly upgrading its weight and status in the manufacturing industry, reflecting the continuous development of equipment manufacturing from low technology to high technology and high technology, reflecting the advanced nature of the development of equipment manufacturing industry. Therefore, this paper uses the proportion of advanced equipment manufacturing industry in the total output value of manufacturing industry as an indicator to measure the high-end level of China's equipment manufacturing industry upgrading. There is no clear definition of advanced manufacturing industry at present. This paper holds that the advanced equipment manufacturing industry should include the equipment manufacturing industry of high-tech industry and the high-end equipment manufacturing industry. The National Bureau of Statistics has clearly defined the division of high-end equipment manufacturing industry (see Table 1 for specific division explanation). The relevant data are

from China Statistical Yearbook, China Industrial Economic Yearbook, China Industrial Yearbook and China High Tech Industry Statistical Yearbook. The data of advanced equipment manufacturing industry are from aviation, spacecraft and equipment manufacturing industry, electronics and communication equipment manufacturing industry, computer and office equipment manufacturing industry, medical equipment and instrument manufacturing industry and transportation equipment manufacturing industry in the list of equipment manufacturing industry (excluding some duplicate data of aviation, spacecraft and equipment manufacturing industry). After 2012, as the relevant statistical yearbook no longer publishes the gross industrial output value, it is replaced by the main business income index. Due to the lack of some data, the 2017 data was backfilled with the average data of the previous two years.

Table 1 Classification of equipment manufacturing industry, high-tech industry, high-end equipment manufacturing industry and advanced equipment manufacturing industry

Equipment manufacturing industry	High tech industry (Manufacturing)	High end equipment manufacturing industry	Advanced equipment manufacturing industry
Metal products industry	Pharmaceutical manufacturing	Aviation equipment industry	Aviation, spacecraft and equipment manufacturing
General equipment manufacturing industry	Aviation, spacecraft and equipment manufacturing	Satellite and application industry	Manufacturing of electronic and communication equipment
Special equipment manufacturing industry	Manufacturing of electronic and communication equipment	Rail transit equipment industry	Computer and office equipment manufacturing
Automobile manufacturing industry	Computer and office equipment manufacturing	Marine engineering equipment industry	Medical equipment and instrument manufacturing
Manufacturing of railway, ship, aerospace and other transportation equipment	Medical equipment and instrument manufacturing	Intelligent manufacturing equipment industry	Rail transit equipment industry
Electrical machinery and equipment manufacturing industry	Information chemicals manufacturing		Marine engineering equipment industry
Computer, communication and other electronic equipment manufacturing industry			
Instrument manufacturing industry			

According to the Classification of National Economic Sectors in 2017 (GB/T 4754-2017)	According to the Classification of High-tech Industry (Manufacturing Industry) published by the National Bureau of Statistics (2013)	According to the Classification of Strategic Emerging Industries (2012) released by the National Bureau of Statistics	At present, there is no clear definition of advanced manufacturing industry. In this paper, advanced equipment manufacturing industry includes high-tech equipment manufacturing industry and high-end equipment manufacturing industry.
---	--	---	--

4.1.2 Explanatory variables

Outward foreign direct investment (OFDI) is used as the explanatory variable. The stock data of outward foreign direct investment of each province in each year is selected, which is derived from the statistical bulletin of China's outward foreign direct investment.

4.1.3 Control variables

4.1.3.1 Enterprise scale (ES), the ratio of the total industrial output value (main business income) of provincial equipment manufacturing industry to the number of enterprise units reflects the scale level of equipment manufacturing industry in each province. It is calculated according to the relevant data of China's industrial economic statistics yearbook and China's industrial statistical yearbook over the years.

4.1.3.2 The proportion of sales output value (PSE), the ratio of sales output value of equipment manufacturing industry to total sales output value of Industrial Enterprises above designated scale reflect the operation status of equipment manufacturing industry in various provinces. It is calculated according to the relevant data of China's

industrial economic statistics yearbook and China's industrial statistical yearbook over the years.

4.1.3.3 The proportion of scientific research personnel (PSA), the ratio of scientific research personnel in advanced equipment manufacturing industry to employees in industrial enterprises above designated size at the end of the year reflects the scientific research level of equipment manufacturing industry in various provinces. It is calculated according to the relevant data of China's industrial economic statistical yearbook, China's industrial statistical yearbook, China's high-tech industry statistical yearbook and China's science and technology statistical yearbook.

4.2 Variable descriptive statistics

The descriptive statistics of each variable are shown in Table 2.

Table 2 Descriptive statistics of main variables

variable	Observations	mean value	Standard deviation	Minimum	Maximum
RE	420	16.05	13.30	0.400	56.85
OFDI	420	292.2	823.1	0.0800	9663
ES	420	2.222	1.278	0.277	6.414
PSE	420	25.56	15.44	3.090	59.97
PSA	420	0.637	0.624	0.0100	3.590

V. EMPIRICAL PROCESS AND RESULT ANALYSIS

Based on the literature of experts and scholars, the following regression model is set up in this paper.

$$HRE_{it} = \alpha + \beta_1 OFDI_{it} + \beta_2 ES_{it} + \beta_3 PSE_{it} + \beta_4 PSA_{it} + \beta_5 D + \beta_6 St + \epsilon_{it}$$

Among them, HRE_{it} is the high-end rate of the equipment manufacturing industry of the i province in the t phase,

that is, the proportion of the advanced equipment manufacturing industry and the total industrial output value of the manufacturing industry (after 2012, the total industrial output value will be replaced by the main business income); $OFDI_{it}$ is the total outward foreign direct investment of the i Province in the t phase. In order to eliminate the influence of exchange rate and price factors, all $OFDI$ values in this paper are exchanged with exchange rate; ES_{it} is the enterprise scale of the equipment

manufacturing industry of the i province in the t phase, that is, the ratio of the total industrial output value (main business income) of the provincial equipment manufacturing industry to the number of enterprise units; PSE_{it} is the ratio of the sales output value of the equipment manufacturing industry of the i Province in the t phase to the total sales output value of the industrial enterprises above the scale; PSA_{it} is the ratio of the scientific research personnel in the t phase of advanced equipment manufacturing industry in the i province to the employees of Industrial Enterprises above the designated scale at the end of the year. α is a constant term and ε_{it} is a random disturbance term.

The panel data model mainly includes fixed effect model, random effect model and mixed model. Before estimating the panel data model, it is necessary to determine which of the three forms is used. The empirical method is to consider the reasonable model form according to the economic relationship of the sample space selected by panel data. The fixed effect model is more suitable.

In this part, two-way fixed effect stepwise regression model is used, and Stata fixed effect model command is used for data regression. The explained variable is the ratio

of advanced equipment manufacturing industry to total industrial output value (main business income) (HRE), and the explanatory variable is OFDI.

5.1 Overall analysis of the whole country

According to the empirical analysis at provincial level, the specific regression results are shown in Table 3. The OFDI coefficient in column (3) of the table is positive, which indicates that OFDI has a positive impact on the high-end rate of equipment manufacturing industry under the control of individual fixed effect, time fixed effect and other factors. It shows that HRE increases by 0.0337% for each unit of OFDI investment. At the same time, the influence of other control variables on HRE is positive, indicating that the enterprise scale, sales share and scientific research level of equipment manufacturing industry have a positive and significant impact on the high-end process of equipment manufacturing industry, and the influence of scientific research level is more significant.

Table 3 Regression results of the model

	(1)	(2)	(3)
	HRE	HRE	HRE
OFDI	0.000840*** (0.000)	0.000101 (0.557)	0.000337* (0.036)
ES		-0.382716*** (0.000)	0.909957*** (0.000)
PSE		0.752459*** (0.000)	0.797787*** (0.000)
PSA		2.047640*** (0.000)	1.902811*** (0.000)
Time effect	No	No	Control
Individual effect	Control	Control	Control
_cons	15.801202*** (0.000)	-3.671009*** (0.000)	-4.160542*** (0.000)
N	420	420	420
R^2	0.042	0.594	0.695

F	16.970014	141.343152	49.960451
---	-----------	------------	-----------

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2 Empirical Analysis on regional level

This paper analyzes the differences of Eastern, Middle, Western and Northeastern China. In this section, we will set three dummy variables, E, M and W. E is the eastern dummy variable. When $E = 1$, it means that the region is the East, otherwise it is other regions; when $M = 1$, it means that the region is the middle, otherwise it is other regions; when $W = 1$, it means that the region is the west, otherwise it is other regions. In order to analyze the regional heterogeneity of OFDI to HRE, this paper multiplies each dummy variable with OFDI to form the cross term OFDI_E, OFDI_M, OFDI_W. This shows that the northeastern region is taken as the comparison object, and the differences among different regions are compared.

Table 4 below shows the regression results. Column (1) is the result of uncontrolled time effect, and column (2) is the result of controlling time effect and individual effect. The result that OFDI is significantly positive indicates that HRE increases by 0.375% for each additional unit of OFDI in the northeastern region. OFDI_E coefficient is significantly negative, indicating that the positive effect of OFDI on HRE in the eastern region is significantly lower than that in the northeast by 0.0035 points. The coefficient of OFDI_M is significantly negative, indicating that the positive effect of reducing OFDI on HRE in Central China is significantly lower than that in Northeastern China by 0.0108 points. Although the OFDI_W coefficient is negative, it is not significant, indicating that the difference between the western region and the northeastern region is not very significant. Furthermore, when the coefficients of OFDI and OFDI_E are combined, they obtain 0.00025, while the coefficients of OFDI and OFDI_M are added to

obtain -0.00713. The results show that the effect of OFDI on HRE is significantly positive in the eastern region, and the HRE increases by 0.025% for each additional unit of OFDI, while it is significantly negative in the middle region, i.e. the HRE decreases by 0.713% for each additional unit of OFDI.

The empirical results of the above regional level are basically in line with China's regional conditions. Northeastern China is an old traditional industrial base of China, where there is a large proportion of equipment manufacturing industry and a good foundation. Moreover, the equipment manufacturing industry in Northeastern China has a great advantage in the "Belt and Road" construction area. The eastern region is the frontier area of China's reform and opening up. Most of the equipment manufacturing industry is high-tech industry with high technology content. The high-end upgrading effect of outward foreign direct investment is not as significant as that of Northeastern China. The equipment manufacturing industry in the middle region is in an important stage of rising, which urgently needs large capital investment. However, outward foreign investment has a "crowding out effect" on the investment of equipment manufacturing industry in the middle region, so outward foreign direct investment has a negative impact on the upgrading of equipment manufacturing industry. The western region is a resource-based and underdeveloped region, and its equipment manufacturing industry foundation is weak, and the scale of foreign direct investment is relatively small. Therefore, the impact of foreign direct investment on the upgrading of equipment manufacturing industry in the western region is not significant.

Table 4 Regression results of the model

	(1)	(2)
	HRE	HRE
OFDI	0.00040 (0.833)	0.00375* (0.038)
ES	-0.28729** (0.004)	0.82308*** (0.000)

PSE	0.85417*** (0.000)	0.85225*** (0.000)
PSA	2.39827*** (0.000)	2.28205*** (0.000)
OFDI_E	-0.00043 (0.820)	-0.00350* (0.050)
OFDI_M	-0.01192*** (0.000)	-0.01088*** (0.000)
OFDI_W	-0.00065 (0.798)	-0.00011 (0.963)
Time effect	No	Control
Individual effect	Control	Control
_cons	-6.43224*** (0.000)	-5.65000*** (0.000)
<i>N</i>	420	420
<i>R</i> ²	0.630	0.719
<i>F</i>	93.11621	47.36715

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

VI. CONCLUSION AND SUGGESTIONS

Based on the panel data of 30 provinces in China from 2004 to 2017, this paper uses a two-way fixed effect stepwise regression model to analyze the impact of outward foreign direct investment on the high-end rate of equipment manufacturing industry, and empirically studies the effect of China's outward foreign direct investment on the upgrading of equipment manufacturing industry. The empirical results show that: China's outward foreign direct investment has a significant impact on the upgrading of equipment manufacturing industry. Further analysis from the regional level, the northeastern region has the most significant positive impact, followed by the eastern region, the middle region has a negative impact, and the western region has no obvious impact. Firstly, the direct impact of outward foreign investment on China's high-end equipment industry is based on the empirical results. Therefore, based on the continuous expansion of outward foreign investment in China's equipment manufacturing industry in recent years, we should continue to increase the

scale of outward foreign direct investment in equipment manufacturing industry, and promote the transformation and upgrading of China's equipment manufacturing industry through "capital going out". The second is to implement the differential incentive policies for outward foreign investment in different provinces. The eastern developed areas and northeastern old industrial bases are also important ones of equipment manufacturing industry. The empirical results show that the effect of outward foreign direct investment on the upgrading of equipment manufacturing industry is positive and significant. Therefore, it is urgent to formulate targeted foreign investment incentive policies to accelerate the pace of equipment manufacturing enterprises in these regions to go global. Third, due to the "crowding out effect" of OFDI, especially in the middle and western regions, it is necessary to adjust measures to local conditions and reasonably control the scale of outward foreign direct investment, so as not to affect the transformation and upgrading of equipment manufacturing industry in these regions.

REFERENCES

- [1] IMF. Foreign Direct Investment Statistics: How Countries Measure FDI [Z]. Washington D.C., 2001:23.
- [2] United Nations Conference on Trade and development. World investment report 1995. Beijing: University of international business and Economics Press, 1996
- [3] Ministry of Commerce. Statistical bulletin of China's foreign direct investment in 2007. Ministry of Commerce, 2008:42
- [4] Porter M.. The Competitive Advantage of Nations [M].London and Basingstoke: Mac Millan, 1990.
- [5] Gereffi G.. International trade and industrial upgrading in the apparel commodity chain [J].Journal of International Economics,1999, (48):37-70.
- [6] Ernst D, KIM L.. Global Production networks, knowledge diffusion, and local capability formation [J].Research Policy, 2002, (31): 1417-1429.
- [7] Poon T S C.. Beyond the global production net-works: a case of further upgrading of Taiwan's information technology industry[J].International Journal of Technology and Globalization 2004, 1(1):130-144.)
- [8] Adler, Michael. THE COST OF CAPITAL AND VALUATION OF A TWO-COUNTRY FIRM[M]// The Journal of Finance. 1974:119–132.)
- [9] Kojima. On foreign trade [M]. Trans. Zhou Baolian. Tianjin: Nankai University Press, 1987
- [10] Blomstrom M, Konan D, Lipsey R E.FDI in the restructuring of the Japanese economy[R] . NBER Working Paper No. 7693,2000.
- [11] UNCTAD World Investment Report 2005. New York and Geneva : UNCTAD Publication, 2005.
- [12] Advincula R. Foreign Direct Investments, Competitiveness, and Industrial Upgrading The Case of the Republic of Korea[J].KDI,2000.
- [13] Gao Lifeng, Li Wenfang, Yu Yaqian. Research on the relationship between foreign direct investment and industrial upgrading in the United States [J]. Economic longitude and latitude, 2013 (6): 72-76
- [14] Zhang Yuanpeng, Li Yujie. Research on the impact of foreign direct investment on China's industrial upgrading [J]. World economic and political forum, 2014, (06)
- [15] Li dongkun, Deng min. inter provincial OFDI, spatial spillover and industrial structure upgrading in China: An Empirical Analysis Based on Spatial Panel Durbin model [J]. International trade issues, 2016, (01): 121-133
- [16] Qi Jianhong, Chen Dong. Japan's foreign investment and "industry hollowing out" crisis [J]. Foreign economy and management, 1996, (06): 32-33
- [17] Shi Liu, Zhang Jie. Research on the correlation between foreign direct investment and industrial hollowing out in Guangdong Province -- an analysis based on grey correlation degree [J]. International business (Journal of University of international business and Economics), 2013, (02): 52-64
- [18] Wang Rong, Wang Ying. ODI and hollowing out of equipment manufacturing industry in the Yangtze River Delta: System GMM analysis based on Dynamic Panel [J]. Social scientist, 2015, (07): 86-90
- [19] Sang Baichuan, Yang Lizhuo, Zheng Wei. Prevention of Industrial Hollowing tendency in the context of China's outward direct investment expansion -- Based on the empirical analysis of Britain, the United States and Japan [J]. International trade, 2016, (02): 8-12
- [20] Fang Yu. Research on the industrial upgrading effect of China's foreign direct investment [D]. Lanzhou University, 2015
- [21] Zhu Chunlan. Analysis of the impact mechanism of foreign direct investment on China's manufacturing industry upgrading [J]. International trade, October 2017
- [22] Liu Xuejiao. Research on GVC pattern, ODI reverse technology spillover and upgrading path of manufacturing industry [D]. University of international business and economics, 2017
- [23] Cao Hongtao. Research on the impact of China's foreign direct investment on the development of advanced manufacturing industry [D]. Wuhan University, 2017
- [24] Huo Xin. Research on the industrial structure upgrading effect of reverse technology spillover of China's foreign direct investment [D]. Capital University of economics and trade, 2016
- [25] Chen Hao. China OFDI and home country industrial upgrading [D]. Zhejiang University, 2018
- [26] Liu Junfang. Research on the impact of foreign direct investment on China's manufacturing industry upgrading North University of technology, 2014
- [27] Jiangdong. Foreign direct investment and home country industrial upgrading: mechanism analysis and empirical study [D]. Zhejiang University, 2010
- [28] Feng Zhijian. Theoretical analysis of FDI and industrial upgrading of home country [J]. Journal of Shenyang Institute of education, 2008 (2)
- [29] Janissa, Shen Chen. Research on the upgrading effect of China's foreign direct investment in manufacturing industry [J]. International investment and transnational operation. 2014 (8): 143-154
- [30] Zhang Cheng, Zhao Gang. Foreign direct investment and upgrading of China's manufacturing industry [J]. Economic and management research, 2018, 6
- [31] Li Chao, Zhang Cheng. China's foreign direct investment and upgrading of global value chain of manufacturing industry [J]. Economic issues exploration, 2017, 11