The Impact of OFDI on the Technical Complexity of High-tech Industry Export in Home Country

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Abstract—This paper calculates the technical complexity of high-tech industry export in 38 countries from 1997 to 2017, discusses the mechanism of OFDI on the technical complexity of high-tech industry export in the home country, and empirically tests the impact of OFDI on the technical complexity of high-tech industry export in the home country by using the System GMM method of dynamic panel data model. The results show that OFDI can improve the technical complexity of high-tech industry export in the home country. After further analysis, it is found that OFDI can only significantly improve the technical complexity of high-tech industry exports from developing countries, but to a certain extent inhibit the developed countries. In addition, FDI, R & D investment, human capital, openness to the outside world and self owned technology can promote the export technology complexity of a country's high-tech industry, while the impact of capital endowment on the export technology complexity of developed and developing countries' high-tech industry is different.

1 Introduction

China has been deeply aware that innovation is the core power to drive development by now. The report at the 19th National Congress of the Communist Party of China stresses the innovation-driven strategy again and points out that the world's technology frontier shall be the yardstick for China's technology innovation and China should maintain its scientific and technological strength come out on top of the world while constructing itself a powerful socialist country. A large number of studies at home and abroad have indicated that the improvement of export commodities' technical content plays a significant role in the economic growth of a country. Since Rodrik (2006), Herzer and Nowak (2006) found out that what matters the most for a country's long-term sustainable economic growth is the quality and technological structure of export, scholars have began to pay attention to study on export technology complexity. Among all industries, the export technology level of the high-tech industry is the most representative of that of a country. And among various influential factors, the influence of outward foreign direct investment (OFDI) on the export technology structure of a country cannot be ignored. By the end of 2017, global OFDI stock had reached 30.8 trillion dollars. Will foreign investment of such a large scale be able to improve each country's high-tech industry export technology level? What's more, there exist differences between developed countries and developing countries in their OFDI momentums, so OFDI has different effects on technological progress of developed countries and developing countries (Kogut and Chang, 1991). So are there any differences between developed countries and developing countries in their high-tech industry export technology complexity? If there are any differences, in what aspects are they reflected? All of these questions are worth deeply exploring under the present global economic development environment.

2 Literature Review

Since Lall et al (2006) first proposed the export technology complexity index which was revised by Hausmann et al (2007), relevant scholars have paid more attention to the study on the technological structure of export commodities. There are quite a few studies at home and abroad on influential factors of the export technology level. Yuan Fang et al (2014) found out that to improve allocation of credit resources and promote improvement of financial competition among regions can not only improve the export technology complexity but make it possible for West China to catch up with and surpass economically developed areas. Chen Xiaohua and Liu Hui (2013) examined the influence of international production fragmentation and factor price on the technology level of China's exports and found out that international production fragmentation has a V-shaped impact on China's export technology level and the rise of factor price looks like an evident "forced" mechanism. Zhu Shujin et al (2010) classified endowment characteristics of factors detailed and tested factors influencing the technology level of exports

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empirically. They found out that human capital, capital-labor ratio, R&D and other variables have significant positive influence on the export technology level, FDI, capital-labor ratio, import trade, R&D investment, human capital and other variables all can promote the improvement of the export technology level, but these factors have different influence on countries with different income levels. Maria Bas, Vanessa Strauss-Kahn (2014) thought that the direct cost and indirect technology spillover are the fixed cost of the import influencing export and two channels that further influence the quality and diversity of exports. Zheng Zhanpeng and Wang Yangdong (2017) thought that R&D investment, import trade, human capital, infrastructure and other factors all can improve the technology level of China's exports significantly while FDI has insignificant inhibitory effect on China's export technology level. Zhang Haibo (2014) empirically tested the influence of OFDI on a country's export technology complexity with dynamic panel data of 71 countries and found out that OFDI has significant positive impact on the export technology complexity of countries with high income levels but has negative effect on countries with low income levels. Yang Jun and Li Ping (2017) found out that import and patent are two spillover channels through which the factor-market distortion can have positive impact on the export technology complexity while export and FDI are two spillover channels through which the factor-market distortion has negative impact on the export technology complexity.

With the development of further research, the research on the complexity of export technology has been refined into service industry and high-tech industry. Mishra et al. and (2011) deepened the research by Hausmann et al., develops the service export complexity index, and studied the relationship between the index and the economic growth. Chen Juncong (2015) found that OFDI can trigger the technology spillover effect of international services industry, and can expand the production technology boundary of the country, and thus to promote the development of technological complexity of the export of a country's service industry; in addition, factors such as property rights protection, domestic technological innovation capacity and service trade openness play important roles in the technological complexity of the export of a country's service industry. Guo Jing and Yang Yan (2010) found that, though the export technology complexity of China's high-tech technology manufacturing industry is increasing, its level still lags behind that of the other countries. Moreover, economic growth can promote the export technology complexity of China's high-tech manufacturing industry. Zhang Ruqing (2012) discovered that, in terms of FDI in manufacturing industry, the FDI of producer services industry could greatly promote the export technical structure of manufactured goods. Wang Lingzhi, Liu Qing (2017) calculated the technical complexity of high-tech exports from 1999 to 2013 in China. It is found that the export technological complexity of high-tech products in China has been increasing year by year, and the R&D investment, economic development level and FID have a positive impact on the technical complexity of high-tech products. In addition, products of high export technology complexity includes office equipments, electronic computers, electronic equipments communication devices.

The existing literatures presents the following trends: first, the influencing factors on the complexity of export technology are gradually expanded from the domestic perspective to the foreign perspective, but the study on the impact of OFDI on the export technology complexity needs to be enriched; second, from the perspective of industry segmentation, the research on the complexity of export technology has shifted from manufacturing to service industry and high-tech industry, but relatively few studies have been done; third, few research on the relationship between OFDI and the export technology of high-tech industries are available at present. This paper studies the influence of OFDI on the export technology complexity of high-tech industries in a country, thus to enrich the study on the export technology complexity of specific industry of a country, and expand the scope of factors that affecting the export technology level of high-tech industries.

3 Study Methods

Based on the theory of Hausmann et al. (2007), this paper extends the model and inspects the influence of OFDI on the complexity of export technology in China. This paper assumes that a country's comparative advantage plays a role in the country's wealth, but it is not decisive. This country has two production departments: one is the modern production department that produces diversified kinds of products, and the other is the traditional department that produces a single kind of products. In addition, an exogenously given world market price P of the single product is assumed as well.

Each product in the modern production department features a certain level of productivity, and the productivity level of the No. I product is indicated by Ai. The productivity level of new products can only be determined after research and development, and can not be decided by investors in advance. However, it can be confirmed that Ai is distributed within the scope of $[0, A^0]$. In Figure 1, once the maximum productivity of a new product is known, there're two strategies for investor's choice: first, when $Ai \geq \theta A^{max}$ (of which θ refers to the R&D simulation efficiency, and $0<\theta<1$), that is, in other words, A_i is within the scope of section II, then, the investor will stick to the R&D of product; second, when $Ai<\theta A^{max,}$ that is, in other words, A_i is within the scope of section I, then the invest will tend to simulate the A^{max} project, and the production will be carried out under the productivity of θA^{max}. Therefore, section II is the production section of investor.

The model established by Levin and Raut (1997) is extended, and we assumed that $A = C(1+\eta E) \times FDI^{\phi} \times OFDI^{\chi}$, of which E refers to foreign trade dependence, OFDI refers to outward foreign direct investment, FDI refers to foreign direct investment, C refers to the internal factor of a country that influencing the technical level, η refers to influencing factor of foreign trade dependence on technology, ϕ and χ refers to the output elasticity of FDI and OFDI technology spillover. According to the conclusions of existing research and the needs of this study, we assumed that C mainly includes domestic R&D capital reserve R, human resources HR, foreign trade dependence E, and original technical level TL, then we can reach the following conclusion:

$$Ae^f = \sigma R^{\chi_1} \times \mathrm{HR}^{\chi_2} \times \mathrm{TL}^{\chi_3} \times (1+\eta E) \times \mathrm{FDI}^{\chi_4} \times \mathrm{O}FDI^{\chi_5},$$

Of which σ is a constant term and χ_i is the technical output elasticity of variables. Then, the technical boundary of section A^0 is determined by R&D capital reserve R, human resources HR, foreign trade dependence E, and original technical level TL, and the extended technical boundary Ae^f of section IV is determined by the technology spillover of FDI and OFDI.

Hausmann (2007) pointed out that, the expected profits of modern sector investors are related to its own productivity A_i and the greatest productivity among other manufacturers $A^{\max}$, of which $A^{\max}$ is determined by production-possibility frontier A^0 and the enterprises' number under the modern department in the country m. as A is equally distributed, so the expected expression of $A^{\max}$ is $E(A^{\max}) = A^0 m/(m+1)$. We assumed m=1 and $E(A^{\max}) = A^0/2$ as the original state. When m tends to infinity, $E(A^{\max})$ will tends to A^0 as a result.

This paper introduces the technology boundary expansion brought by FDI and OFDI from the external knowledge revenue channel, so the above formula can be amended as $E(A^{\max}) = Ae^f m/(m+1)$, of which f refers to the total of technology spillover brought by FDI and OFID. When f=0, $E(A^{\max}) = A^0 m/(m+1)$. With the increasing of f, $E(A^{\max})$ will tend to Ae^f.

The probability of an enterprise sticking to independent R&D is $p(A_i \geq \theta A^{\max}) = 1 - \alpha E(A^{\max})/Ae^f = 1 - am/(m+1)$, as the production technology A_i of the enterprise is distributed equally within $(\theta A^{\max}, Ae^f)$, and the expected productivity is $(Ae^f + \theta A^{\max})/2$, so we can calculate the expected profit of independent R&D enterprise through $E(\pi | A_i \geq \theta A^{\max}) = \frac{1}{2} p[Ae^f + \theta E(A^{\max})] = \frac{1}{2} Ae^f [1 + \theta m/(m+1)]$; with the same method, we can calculate the probability of enterprise simulating the advanced technology through formula of $p(A_i < \theta A^{\max}) = \theta E(A^{\max})/Ae^f = \theta m/(m+1)$, under which the enterprise carries out production with the constant productivity of $\theta A^{\max}$, so the exptected productivity is $\theta A^{\max}$. Then we can calculate the expect profit of enterprise simulating the advanced technology through formula $E(\pi | A_i < \theta A^{\max}) = p\theta E(A^{\max}) = pAe^f \theta m/(m+1)]$, and the expected profit of enterprise either sticking to independent R&D or simulating technology through formula of $E(\pi) = \frac{1}{2} Ae^f [1 + (\frac{\theta m}{m+1})^2]$, thus, the expected productivity of enterprise can be expressed by $E(A_i) = \frac{1}{2} Ae^f [1 + (\frac{\theta m}{m+1})^2]$.

We assumed the labor force physical capital as the main production factors of modern department, with the function expression of $Y = AL^{\alpha} K^{\beta}$; and we assumed the scale and remuneration to be constant, that is $\alpha + \beta = 1$, of which L refers to labor force, K refers to material capital and Arefers to production technology level. Substitute $E(A_i)$ into the production function in order to get the expected profit, then we can get that:

$$E(Y) = \frac{1}{2}\sigma[1 + (\frac{\theta m}{m+1})^2] R^{\chi_1} \times \mathrm{HR}^{\chi_2} \times \mathrm{TL}^{\chi_3} \times (1+\eta E) \times \mathrm{FDI}^{\chi_4} \times \mathrm{O}FDI^{\chi_5} \times \mathrm{L}^{\alpha}\mathrm{K}^{\beta} \quad (1)$$

Divide both sides of formula (1) by the labor scale L, and we can get that:

$$E(Y)/L = \frac{1}{2}\sigma[1 + (\frac{\theta m}{m+1})^2] R^{\chi_1} \times \mathrm{HR}^{\chi_2} \times \mathrm{TL}^{\chi_3} \times (1+\eta E) \times \mathrm{FDI}^{\chi_4} \times \mathrm{O}FDI^{\chi_5} \times (\mathrm{K}/\mathrm{L})^{\beta} \quad (2)$$

take the logarithm of both sides in formula (2), and we can get that:

$$\ln[E(Y)/L] = C_0 + \chi_1 \ln R + \chi_2 \ln \mathrm{HR} + \chi_3 \ln \mathrm{TL} + \ln(1+\eta E) + \chi_4 \ln \mathrm{FDI} + \chi_5 \ln \mathrm{O}FDI + \beta \ln(K/L) \quad (3)$$

When ηE is very small, $\ln(1+\eta E) \approx \eta E$, so formula (3) can be expressed as follows:

$$\ln[E(Y)/L] = C_0 + \chi_1 \ln R + \chi_2 \ln \mathrm{HR} + \chi_3 \ln \mathrm{TL} + \chi_4 \ln \mathrm{FDI} + \chi_5 \ln \mathrm{O}FDI + \chi_6 \mathrm{E} + \chi_7 \ln(K/L) \quad (4)$$

of which, C_0 is the constant term and $E(Y)/L$ is per capita GDP. As the export technology computational formula of the export technology complexity is directly proportional to output per capita, therefore the output per capita $E(Y)/L$ can be used to represent the export technology complexity of the modern industrial departments (Zhang Haibo, 2014). In compliance with formula (4), the measurement model is established as follows:

$$\mathrm{lnexpy}_{it} = C_0 + a\mathrm{lnOFDI}_{it} + b_i \sum \mathrm{ln}A_{it} + cE_{it} + d_i \sum \mathrm{ln}B_{it} + u_i + e_{it} \quad (5)$$

In formula (5), OFDI is a key index of this paper and A, E and B represent the other control variable. A represents the regional endowment, including capital endowment (K/L) and proprietary technology (TL); E represents foreign trade dependence degree; B represents other technology spillover channels (FDI) and "absorptive capacity" to the technology spillover (human resource HR and R&D reserve (R). The subscript i represents the region, t is for the year, and respectively represent the regional fixed effect and the random error term. After Hausmann inspection, we can decide which one to choose between the fixed effect model and random effect model.

As both export behavior and OFDI behavior are dynamic continuous processes in the real economy, so the export technology complexity of the high-tech industry of a country is not only effected by the current factors, it is also influenced by the export technology complexity of the high-tech industry of last period. Therefore, the static panel data measurement model of formula (5) is verified as follows:

$$lnexpy_{it}=C_0+alnOFDI_{it}+b_i\sum lnA_{it}+cE_{it}+d_i\sum lnB_{it}+ flnexpy_{it-1} u_i+e_{it} \quad (6)$$

4 Data Source and Objects of Study

4.1 Explained variables

Export technology complexity of high-tech industry is an explained variable of this paper, which uses the export technology complexity index (expy) established by Hausmann, Hwang & Rodrik (2007) to measure the export technology complexity of the high-tech industry of a country. As to measure the export technology complexity of the high-tech industry of a country, we shall first measure the export technology complexity indexes (prody) of various high-tech products with the formula as the follows:

$$prody_{jk}=\sum_j[(X_{jk}/X_j)/ \sum_j(X_{jk}/X_j)]y_j$$

of which, X_{jk} represents export volume of category k high-tech products of country j, X_j represents the total export of country j and y_j is the per capita income of country j, and $prody_{jk}$ is the technology complexity of category k high-tech export products of country j, therefore, the higher $prody_{jk}$ is, the higher the export technology complexity is of this category high-tech products and otherwise, the lower the export technology complexity is of this category high-tech products.

On the basis of computation of various high-tech export products' technology complexity, the computational formula of the export technology complexity (expy) of high-tech industry is as follows:

$$expy_{jk}=\sum_k[(X_{jk}/X_j) prody_{jk}$$

From this formula, we can see that the export technology complexity index of high-tech industry of a country is the weighted average of the technology complexity indexes of all the exported high-tech products of this country, and weight is the proportion of the export volume of various high-tech products in the total export of this country, which means the more products of high export technology complexity are, the higher the value $expy_j$ is and the higher the export technology complexity of high-tech industry of this country is.

The high-tech industry classification standard of this paper is based on *Classification of High-tech Industries (Manufacturing) (2013) of China*, it is because this standard has referred to the classification methods of OECD for the high-tech industries and has based on *Industrial Classification for National Economic Activities (GB/T 4754-2011)* further classified those activities in the national economy with their industrial classifications related to the high-tech manufacturing range. And moreover, this classification standard can be linked to the international classification standard and is more applicable for analysis on the internationally related issues. According to this standard, the high-tech industry can be: aviation, spacecraft and equipment manufacturing, information chemical manufacturing; electronics and communication equipment manufacturing; computer and office appliance manufacturing; pharmaceutical manufacturing; medical equipment and instruments manufacturing. In the statistics of the high-tech manufacturing industry, this paper has excluded aviation, spacecraft and equipment manufacturing industry as the proportion of this industry in various countries is comparatively small, which may produce influences to the calculation results, and besides, as combined with the product classification standard of the United Nations, this paper has combined the high-tech related industries in compliance with the above mentioned classification standard by using SIT C4.0 export trade data in UN COMTRADE database. The per capita GDP and export volume of the measurement are both from the statistics database of the World Bank.

In view of the length and availability of data, this paper has selected 38 countries of the top 42 export trade volume proportion in the global export volume from 1997 to 2017 as the objects of sample, exclusive of UAE, Saudi Arabia, Iran and Hong Kong. The total export of these 38 countries in 2017 have exceeded 80% of the gross export of the world and in the most of the previous years, their total export can also basically reached over 80% of the gross export globally. Therefore, these 38 countries or regions of the paper are comparatively high representative during the period of the samples.

4.2 Explanatory variables

The main explanatory variable of this paper is OFDI. A "learning process" is required before the OFDI be absorbed and exert effect on a country's reverse technology spillover; in addition, as the reserve data can represent the Overseas assets scale (Dunning, 2001) of a country better, so the paper adopts the OFDI reserve (OFDI) of the current period and the OFDI reserve of the 3 period in the future ($OFDI_{t-3}$)(Kemeny, 2010) as the two variables to represent the OFDI level of the country.

4.3 Controlled variables

Human resources (HR) is determined by the level of education in one country. In this paper, education enrollment rate is used to represent education level in the country (Schott, 2008); capital level (K) is represented by the gross capital formation; labor scale (K) is represented by total labor force; original technical level (TL) is represented by patent applications from residents; the foreign direct investment (FDI) is represented by the current FDI reserve and the FDI reserve (FDI) in the future three period (FDI_{t-3}).

The relevant data of OFDI and FDI stock are derived from the United Nations Conference on Trade and Development (UNCTAD). The total number of labor force, total capital formation, high education enrollment rate and resident patent application are all from the World Bank.

5 Empirical Results and Discussion

In this part, panel data of 38 countries from 1997 to 2017 were measured empirically, and the impact of OFDI on the technical complexity of export of high technology industries in the home country was investigated. A total of 38 countries, including 23 developed countries and 15 developing countries, were selected as samples, as in abide by the principle of the diversity of country types, the representation of national data and the availability of variable data. See Table 1 for the descriptive statistics of explained variable and explanatory variable. In order to realize a stable estimation, and according to formula (5) and (6), three combinations of statistics from sample countries, developed countries and developing countries were analyzed, and static panel data model OLS and dynamic panel data model System GMM are used as the main method for estimation. See Table 2 for details. As the export technology complexity of the high-tech industry at the early stage and the influence of OFDI and FDI on the current period are not fully included in the static panel data, so we put emphasis on the estimation results of the dynamic panel data analysis, while taking the estimating result from static panel data as reference.

Table 1 Descriptive statistics

Varialbs	Mean value	Standard deviation	Minimum value	Maximum value
lnexpy	9.703	1.674	3.406	14.05572
lnFDI	12.131	2.302	4.584	15.981
lnFDI	11.905	1.413	6.822	16.033
E	93.631	74067	15.623	443.576
lnHR	3.891	0.553	1.501	4.722
lnTL	8.223	2.062	3.432	13.898
lnK/L	8.982	1.239	5.804	11.005
lnR	27.754	1.802	23.745	32.213

5.1 Analysis on the whole sample countries

Table 2 Measurement estimation results

Varialbs	All sample countries		Developed countries		Developing countries	
	Model 1 FE	Model 2 System GMM	Model 3 FE	Model 4 System GMM	Model 5 FE	Model 6 System GMM
Expyt-1	——	0.341***	——	0.273***	——	0.181
		(15.56)		(2.84)		(1.41)
OFDI	0.029	0.075	-0.064	-0.048	0.079***	-0.055
	(1.57)	(1.46)	(-1.29)	(-1.54)	(4.31)	(0.07)
OFDIt-3	——	0.019*	——	-0.027*	——	0.13*
		(1.92)		(-1.56)		(1.81)
FDI	0.031	0.142***	0.234***	0.342**	-0.117***	0.185
	(1.38)	(3.22)	(5.57)	(2.44)	(-4.72)	(0.93)
FDIt-3	——	0.101*** (2.76)	——	0.201** (2.11)	——	0.312 (0.67)
R	0.169***	0.248***	0.082	0.643***	0.193***	0.208*
	(4.58)	(1.99)	(1.01)	(2.63)	(5.43)	(1.89)
HR	0.049	0.287***	0.047	0.321	0.120***	0.562*
	(1.32)	(2.49)	(0.57)	(1.53)	(4.46)	(1.93)
TL	0.072***	0.038	0.153***	0.049*	0.019	0.632
	(3.45)	(1.21)	(4.05)	(1.58)	(0.84)	(0.56)
E	0.001***	0.002*	0.0006**	0.0004	0.003**	0.011
	(4.33)	(1.87)	(2.50)	(0.13)	(4.13)	(1.06)
K/L	0.501***	0.356***	0.518***	-0.085	0.589***	0.648
	(13.69)	(3.76)	(7.52)	(-0.55)	(17.05)	(1.57)
Hausman	514.31	——	181.43	——	587.03	——
Ajusted R2	0.8391	——	0.7321	——	0.9305	——
AR（1）	——	0.002	——	0.001	——	0.001
AR（2）	——	0.831	——	0.902	——	0.852
Sargan	——	32.86	——	34.61	——	31.69

(1)The empirical results show that, within the scope of whole sample data, OFDI can improve the export technical complexity of high-tech industries in the home country. In the estimation results of static and dynamic panel data model, the coefficient of OFDI is positive but not significant. In the dynamic model, the coefficient of OFDI reserve $OFDI_{t-3}$ in the future three periods is positive and significant. A 1% increase in $OFDI_{t-3}$ results in the decrease of technical complexity index of the high-tech industry in the home country by 0.02%. Both static and dynamic model of the empirical results show that, by taking into consideration the influence of the last period on the export technology level of the high-tech industry in the current period, the $OFDI_{t-3}$ reserve has no significant influence on the technical level of the export product but has significantly positive influence on the technical level of export technology in the home country. It indicates that the home country need to get the reverse technology spillovers of OFDI through a learning process, thus to improve the export technology complexity of high-tech industry. This conclusion conforms to the theoretical expectation.

(2)FDI has a positive influence on the export technology complexity of high-tech industries. In the static model estimation, the FDI reserve has no significant positive influence on the complexity of export technology of a country's high-tech industry. In the dynamic model estimation, the variable FDI and FDI_{t-3} has positive influence on the export technology complexity of high-tech industry, and has passed the significance level test at a influence of 1%. It indicates that the FDI and FDI_{t-3} has positive and significant influence on the export technology complexity of high-tech industry, by taking into consideration the influence of the last period on the export technology level of the high-tech industry in the current period.

(3)R&D capital reserve (R), foreign trade dependence (E), and capital endowment (K/L) have a significant positive effect on the export technological complexity of a country's high-tech industries. In both static and dynamic model estimation, the three variables have passed the significance test, and the estimated coefficient is positive. It indicates that the R&D capital stock, the dependence of foreign trade and the original technology level have positive effect on the export technology complexity of a country's high-tech industry, which is in line with the theoretical expectation.

(4)Human resource (HR) and technology (TL) have a positive effect on the export technology complexity of a country's high-tech industries. The estimated coefficients of these two variables are positive in both static and dynamic models. The positive influence of HR fails to pass the significance test under the static model, but passes the significance test under the dynamic model. It indicates that, through the learning process of OFDI reverse technology spillovers for three period, the human resource will improve the export technology complexity of the high-tech industry in the country. On the contrary, the positive influence of TL fails to pass the significance test under the dynamic model, but passes the significance test under the static model. It indicates that the proprietary technology of the current period have a positive influence on the export technology complexity of the high-tech industry in the country.

5.2 Comparative analysis of developed countries and developing countries

(1)In the static panel model, OFDI has a negative influence on the export technology complexity of high-tech industries in developed countries and has positive influence on developing countries. The variable OFDI passes the significance test only in the static panel model of developing country. In the dynamic panel model, the influence of variable OFDI on the export technology complexity of high-tech industry in developed and developing countries is negative and not significant. However, the estimation of $OFDI_{t-3}$ passes the significance test, with negative influence on the developed countries and positive influence on the developing country. It indicates that the OFID promotes the improvement of export technology complexity of high-tech industry in the developing country, and the improvement of export technology complexity of high-tech industry in the developed country. The reason for the result is that, in actual operation, the advanced country always take the market exploring, production transferring and resource seeking as the main motivation, so the destination countries are generally with underdeveloped economy or natural resources, with their technical level lower than that of the home country; even though the developed country belongs to the type of technology seeking, due to its high technical level, it will realize reverse technology spillovers in the destination country, thus, it will also have a relatively low influence on improving the export technology complexity of its high-tech industries. The OFDI in the developing countries always aims at technical and market seeking, and with comparatively low technical level, the home country can receive the reverse technology spillovers through OFDI from the invested country with comparatively higher technical level, thus to improve the export technology complexity of the home country. However, as the "absorption capacity" in developing countries is limited, the OFDI will not positively influence the export technology complexity in the current period. Such positive influence will appear through the learning for a certain period of time, that is to say, the $OFDI_{t-3}$ will have a significant positive influence on the export technology complexity of high-tech industries in the home country.

(2)In the static and dynamic panel data of developed countries, variables FDI and $OFDI_{t-3}$ are significantly positive, indicating that FDI inflows have a positive influence on the export technology complexity of high-tech industries in developed countries, and indicates that the developed countries has high learning capacity, and is sensitive with the new technology brought by the foreign investment with long duration. This also proves the internal mechanism that FDI can improve export technology complexity of the high-tech industry through technology spillover effect. In the static panel data model of the developing countries, the estimated coefficient of variable FDI is negative, and the significance test is passed as well. However, in the dynamic model, the estimated coefficient of both FDI and $OFDI_{t-3}$ is positive but not significant. It indicates that the FDI inflows have a positive influence on the export technology complexity of high-tech industries in developing countries, but such influence is not significant. This is mainly due to the fact that foreign investment introduced by the developing countries is mainly from the developed countries in seeking market and cheap labor force, therefore, its influence on the technical improvement is not obvious.

(3)Effects of R&D capital reserve (R) on the high-tech industry export technology complexity of the developed and developing countries are both significantly positive and the estimated coefficient in the dynamic model of the developed countries is comparatively large, which means R&D input can promote the export technology complexity of the high-tech industries of the developed and developing countries, and especially of the developed countries in view of the hysteresis of 3 stages of the outward foreign investment. Effects of human resource (HR) on the high-tech industry export technology complexity of the developed and developing countries are both positive, which however has only passed the significance tests in the static and dynamic models of the developing countries but not such significantly in the developed countries. It is probably due to the comparatively high human resource level of the developed countries, which has produced small border effects on the export technology complexity of the high-tech industry. But to the other way around in the developing countries, as the original human resource level is comparatively low and once the level increases slightly, namely a small improvement of the "learning ability", the technology spillover brought by FDI and OFDI would be significantly absorbed so as to greatly promote the export technology complexity of the high-tech industry of the country.

(4)Effects of proprietary technologies (TL) on the high-tech industry export technology complexity of the developed and developing countries are both positive, which however has only passed the significance tests in the static and dynamic models of the developed countries. It is probably due to the comparatively low proprietary technology level of the developing countries, which has produced insignificant effects on the export technology complexity of the high-tech industry of the country. Both openness (E) and capital endowment (K/L) have significant positive effects on the static panel data model of the developed and developing countries but not so significant dynamically, which means the openness and capital endowment can greatly promote the export technology complexity of two kinds of national high-tech industries

6 CONCLUSIONS

The research results of this paper can provide various reference ideas on the implementation of "Made in China 2025" and innovation-driven development strategies, which especially have very important policy meanings to the promotion of high-tech industrial export and high-tech product export quality. To sum up, it can provide theoretical basis for the acceleration of "going out" steps and promotion of the export structure upgrading of the high-tech industry of our country.

(1)OFDI scale expansion is conductive to the promotion of export technology level of the high-tech industries of the developing countries and such promotion can only be significantly reflected after a certain time of "learning" of the reverse technology spillover of the outward foreign investment. However, it has inhibiting effects on the export technology level of the high-tech industries of the developed countries, because it is closely related to the outward foreign investment motives and investment categories of the developed countries.

(2)Human resource can promote the export technology level of the high-tech industries of the developed and developing countries and especially the developing countries, but not so significantly of the developed countries. As the absorption of human resources has border effect on the technology promotion, so such border effect would be comparatively great for the developing countries of comparatively low human resource level and also for the promotion of technologies.

(3)FDI has significant promotion effect on export technology level of the high-tech industries of the developed countries but not so significant of the developing countries, and when not considering the dynamic effects of the foreign investment, it may even hinder the promotion of the export technology level of the high-tech industries of the developing countries, which is due to the high human resource level and learning abilities of the developed countries and they can absorb the technology spillovers brought by the foreign direct investments well and quickly. However, most of the foreign investments absorbed by the developing countries are the market-seeking and production-transferring types, which are not so conductive to the promotion of the technologies.

(4)Both openness and resource endowment can promote the export technology levels of the high-tech industries of developing and developed countries. And for the developed countries, as for the expansion of overseas market demands for the high-tech products, the domestic high-tech enterprises would be stimulated to increase investment on research and development to promote the international competitiveness of their high-tech products so as to accelerate the promotion of the export technology contents of the high-tech products. And for the developing countries, by means of import of high technical content products, they can promote their own international technology R&D spillover so as to accelerate the development of the high-tech industries and promote the export technology contents of the high-tech industries. And moreover, with higher per capita capital, they can get higher technology promotions.

(5)The proprietary technologies have both positive effects on the export technology levels of the high-tech industries of developing and developed countries and more significant for the developed countries. Depending on their own technology levels and continuous technology innovative capabilities of the developed countries, they can significantly promote the technology level of their high-tech products and however, due to the comparatively low proprietary technology levels of the developing countries, insufficient R&D input and weak innovative capabilities, the technical contents of the high-tech export products of such countries are greatly hindered.

(6)R&D input can promote the export technology level of the high-tech industries of the developed and developing countries and can promote the level greatly in the current period and some time when considering the outward foreign investment. It means that whether the economy of a country is advanced or not, the export technology level of the high-tech industry can be significantly promoted with active R&D input.

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