The Influence of Foreign Direct Investment on China's High-tech Industry Innovation——A Mediation Effect Model

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Abstract— Based on the panel data of China's provinces from year 2009 to 2018, the internal R&D cost is introduced as an mediation variable, and the Bootstrap method is used to study the impact of foreign direct investment on China's high-tech industry innovation through the mediation effect model. The results show that, in general, foreign direct investment can promote the innovation of China's high-tech industries, but the direct effect is relatively weak. At the same time, R&D internal expenses play a significant mediation role in the impact of foreign direct investment on China's high-tech industry innovation. Therefore, in order to further promote the innovation of China's high-tech industry, it is necessary to increase the attraction of foreign investment, increase the investment in research and development expenses, and pay attention to the learning of core technologies.

Keywords— Foreign direct investment; high-tech industry innovation; mediation effect.

I. INTRODUCTION

High-tech industry is an industry group that uses high-precision technology to produce products, with the characteristics of high efficiency, high investment, and intelligence. In recent years, China's high-tech industry has developed well: the operating income of the high-tech industry has increased from 5956.67 billion yuan in year 2009 to 157.11 billion yuan in year 2018; the number of patent applications has also increased from 41170 pieces in year 2009 to 425,137 pieces in year 2018. On the other hand, since the promulgation of the "Foreign Investment Law of the People's Republic of China" in 2019, foreign investment has entered a new stage of institutional opening up. Among them, the actual use of foreign direct investment increased from US$90,033 million in year 2009 to US$13,496,589 million in year 2018. So, does foreign direct investment play a positive role in the innovation of high-tech industries? How can foreign investment be better used in the R&D and innovation of domestic high-tech industries? High-tech industry, as a relatively intensive industry of China's foreign direct investment, represents the development direction of advanced productivity, and is closely related to the country's future innovation capabilities. It is very necessary to study the impact of foreign direct investment on China's high-tech industry innovation.

II. LITERATURE REVIEW

A. Foreign direct investment and high-tech industry innovation

According to current research, the impact of foreign direct investment on innovation is different. Some scholars believe that foreign direct investment has a positive effect on innovation, such as Cheung and Lin (2004)[1], Alazzawi S. (2012)[2], Masso (2013)[3], Smith (2017)[4], etc. It has been found that foreign direct investment has a positive effect on technological innovation in China, Estonia, Russia and other

countries; some scholars believe that foreign direct investment has no positive effect on innovation, such as Aitken B J. and Harrison AE. (1999) [5] A study of 4000 companies in Venezuela found that, on the whole, foreign direct investment has a negative effect on technological innovation. Blomstrom (2001)[6] and others believe that the positive impact of foreign direct investment is related to the policies and characteristics of the host country.

Pan Zhen (2005) [7] found that foreign direct investment has had a positive effect on China's scientific and technological innovation activities by improving the output efficiency of domestic scientific and technological capital input. Fan Chengze (2008) [8] and Yu Yongze (2011) [9] also reached similar conclusions. Ye Jiao and Wang Jialin (2014)[10] supplemented and supported the above conclusions based on the panel data of Jiangsu Province. Qian Long's (2020) research found that FDI in the technology service industry has significantly improved China's manufacturing innovation capabilities. However, Zhou Yanmei (2011) [11], Wang Qianli (2012) [12] and Wu Baiyu (2016) [13] found that foreign direct investment has no significant or insignificant promoting effect on technological innovation through empirical analysis of manufacturing technology innovation. In terms of high-tech industries, Yue Shujing (2009) [14], Wang Yongjun and Qiu Zhaolin (2016) [15] based on China's high-tech industry research found that foreign direct investment has a positive impact on the technological innovation of domestic enterprises. Zhang Jing (2002)[16] believes that foreign capital has the problem of stricter core technology blockade on the development of China's high-tech industry and insignificant promotion of domestic enterprises. Niu Zedong (2011) [17] and other studies found that the positive effect of foreign direct investment on high-tech industries is based on the premise that enterprises have certain absorption conditions.

B. The mediation role of R&D expenses

Due to the high investment in high-tech industries, the most important thing in the innovation process is the amount

of R&D investment. Long-term large amounts of sufficient funds can support the independent innovation activities of enterprises and promote the output of new technologies and new products. Hu Ping (2017) [18] found that the interactive effect of enterprise R&D expenditure and innovation output is significant. Lu Xin (2013) [19] based on the empirical research of high-tech listed companies found that R&D funds and independent innovation of enterprises have a significant positive effect based on the empirical analysis of 216 listed companies in China's strategic emerging industries, Li Miaomiao (2014) [20] found that R&D funding has a simple positive impact on technological innovation capabilities. Foreign direct investment, as a direct investment in China by foreign companies or individuals using cash, in kind or technology, has met a considerable part of the capital and technology needs of domestic companies.

In summary, the research conclusions of scholars on the impact of foreign direct investment on technological innovation vary depending on the actual situation of the research country and the development of the research industry. The research of domestic scholars is concentrated in the field of manufacturing, the research on high-tech industries is still insufficient and the path of the influence of foreign direct investment on high-tech industry innovation is not clear enough. The high-tech industry, as an industry with relatively intensive foreign direct investment in China, represents the development direction of advanced productivity and is closely related to the country's future innovation capabilities. We should focus on this. Therefore, this article takes China's high-tech industry as the research object, selects the data on the development of high-tech industries in various provinces from year 2009 to 2018, and attempts to construct a mediating effect model with moderating variables based on existing research and actual conditions to explain the foreign direct investment in China, try to explain the impact of high-tech industry innovation and give some corresponding recommendations.

III. MODEL DESIGN

The empirical analysis of this article refers to the research of Wen Zhonglin and Ye Baojuan (2014) [21], using the PROCESS mediation effect test function of SPSS18 to analyze the mediation effect of foreign direct investment in promoting high-tech industry innovation. Therefore, the theoretical regression model of the mediation effect is as follows:

- $\ln ZLS_{it} = c'\ln JRFZ_{it} + b1\ln FDI_{it} + b2\ln RDFY_{it} + \mu_{it}$
- $\ln RDFY_{it} = a2\ln FDI_{it} + d\ln FDI_{it} + \tau_{it}$
- $\ln FDI_{it} = a1\ln JRFZ_{it} + \sigma_{it}$

Combined with the research object of this article, suppose the actual use of foreign direct investment is the independent variable X, the high-tech industry innovation is the dependent variable Y, the internal expenditure of R&D expenditure is the intermediate variable M, and the full-time equivalent of R&D personnel and financial development are the control variables, μ, τ and σ are regression residuals, and i and t represent province and year respectively.

A. Variable selection and data sources

The sample interval selected in this article is year 2009 to 2018, including 29 provinces, cities, and autonomous regions in China (Qinghai Province and Tibet Autonomous Region are not included in the statistics due to lack of data). The data comes from the "China Statistical Yearbook", "China High-tech Statistical Yearbook", wind database and statistical yearbooks of various provinces.

Number of valid invention patents (ZLS). That is, the number of invention patents owned by the enterprise as the first patentee, authorized by the intellectual property department and within the validity period. Compared with the commonly used index of patent authorization, the number of valid patents can more intuitively reflect the effective innovation of high-tech enterprises. This article uses this to measure the innovation of high-tech industries.

Actual utilization of foreign direct investment (FDI). This article chooses to actually use the product of the amount of foreign direct investment and the central parity of the RMB against the US dollar as the measurement method of the dependent variable.

R&D internal expenses (RDFY). The more the company spends on internal R&D activities, the greater the support for the company's high-tech development, and the higher the possibility of new research results. This article chooses R&D internal expenses as the mediation variable.

Control variables. ①Financial Development (JRFZ): Financial development is an important indicator of a country's degree of development. The academic circles mostly use the research of American economist Raymond W. Goldsmith to measure the financial correlation rate, that is, the ratio of the value of financial assets to the total economic activity of the country on a certain date. Subject to the unavailability of data, this paper chooses the proportion of financial institution loan balance to GDP as a measure of financial development. ②R&D personnel equivalent full-time equivalent (RDRY): Refer to the practice of Dou Penghui and Chen Shibo (2012)[22], and select "R&D personnel full-time equivalent" as the scientific and technological manpower input indicator.

IV. EMPIRICAL ANALYSIS

A. Regression analysis of mediation variables and dependent variables

This study uses 10-year panel data from 29 domestic provinces and selects the mediation effect regression model 4. It takes actual use of foreign direct investment as the independent variable, high-tech industry innovation as the dependent variable, internal R&D expenditures as the mediating variable, and the effect of the mediating variable is tested. Through the PROCESS plug-in of SPSS18, with the Bootstrap sample size set to 5000 and 95% confidence interval, the data was processed, and the following results were obtained.

The judgment method is based on whether the confidence interval of its coefficient contains 0: it is significant if the interval does not contain 0.Including 0 is not significant. It can be seen from Table 1 Model 1, the actual use of foreign direct

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investment has a positive effect on R&D internal expenses. The confidence interval is (0.0512, 0.1377), excluding 0, which indicates that the effect is significant, and the p value is less than 0.01, passing the 1% significance test, and the coefficient is 0.0944. It shows that foreign direct investment provides a strong support for R&D expenditures, and foreign financial support is also an important part of R&D expenditure. In Model 2, the actual use of foreign direct investment and internal R&D expenses both have a positive effect on the development of high-tech industries. R&D internal R&D expenses are particularly significant, with a

confidence interval of (0.8119, 1.1709), excluding 0, indicating a significant effect, p value is less than 0.01, passing the 1% significance test, and the coefficient is 0.9914. The confidence interval for financial development is (0.7006, 1.1446), excluding 0, which is significant, p value is less than 0.01, indicating that financial development has a significant effect on the actual use of foreign direct investment to influence the innovation of high-tech industries. However, neither the researchers' confidence interval nor the p-value passed the test, indicating that the number of researchers does not have that much effect.

TABLE 1. Regression analysis results

Variable	Model1				Model2			
	outcomes：lnRDFY	p-value	LLCI	ULCI	outcomes：lnZLS	p-value	LLCI	ULCI
constant	3.0721***	0.0000	2.8421	3.3021	-5.5470***	0.0000	-6.2027	-4.8913
lnFDI	0.0944***	0.0000	0.0512	0.1377	0.0513	0.1436	-0.0175	0.1201
lnRDFY					0.9914***	0.0000	0.8119	1.1709
lnJRFZ	0.5490***	0.0000	0.4200	0.6780	0.9226***	0.0000	0.7006	1.1446
lnRDRY	0.9657***	0.0000	0.9248	1.0066	0.0008	0.9932	-0.1837	0.1853

B. Mediation effect test

Table 2 shows the direct and indirect effects of actual use of foreign direct investment on high-tech industry innovation. The direct effect of foreign direct investment on high-tech industry innovation is 0.0513, the confidence interval is (-0.0175, 0.1201), including 0, indicating that the direct effect of actual use of foreign direct investment on high-tech industry innovation is not significant. But according to Hayes, the insignificant direct effect does not affect the study of the mediation effect. The indirect effect is 0.0936, the confidence interval is (0.0490, 0.1438), excluding 0, indicating that R&D internal R&D expenses play a significant mediation role in the path of actual utilization of foreign direct investment on the innovation of high-tech industries, that is, China's high-tech industries is possible to increase the cost of internal R&D through the use of foreign direct investment, then generate more patented technologies and promote the innovative development of the industry. Among them, the indirect effect accounts for 64.60% of the total effect, and the direct effect accounts for 35.40% of the total effect. The indirect effect plays a more obvious role in promoting.

TABLE 2. Direct and indirect effects of actual use of foreign direct investment on high-tech industry innovation

Variable	Total effect	Direct effect	Indirect effect
Effect	0.1449	0.0513	0.0936
BootSE	0.0402	0.0350	0.0241
BootLLCI	0.0657	-0.0175	0.0490
BootULCI	0.2240	0.1201	0.1438

V. CONCLUSIONS AND POLICY RECOMMENDATIONS

A. Research conclusion

Studies have shown that R&D internal R&D expenses have a significant mediating effect in the impact of foreign direct investment on high-tech industry innovation. However, the direct effect of foreign direct investment on the innovation of China's high-tech industry is not significant. This may be due to the limited technological level of China's high-tech enterprises and it is difficult to absorb foreign technology for

innovation, or because foreign companies retain part of the core technology. Foreign direct investment is not conducive to the innovation of China's high-tech industries. Although foreign direct investment provides sufficient financial support, it will also cause the impact of foreign direct investment on the innovation and development of China's high-tech industry to be not significant.

B. Policy recommendations

First, improve the financial market and promote industrial transformation and upgrading. To increase support for the financial market, government must provide a more complete system of laws and regulations to make China's financial market more standardized and corporate financing channels more reliable, so that "there are laws to follow". The other is to provide more financial support, As a high-input industry, the high-tech industry can promote the improvement of China's independent innovation capability quickly and well only if it has sufficient supporting funds. This is directly reflected in the increase in the number of effective invention patents. What's more, it is necessary to improve the financial market system, strengthen infrastructure construction, and provide a better business environment.

Second, focus on attracting foreign investment and learning foreign core technologies. Foreign direct investment can provide capital and technology needed to boost the innovation and development of high-tech industries. On the other hand, we must be aware of foreign businessmen using Chinese enterprises as "processing factories". While continuously promote reform and opening-up, high-tech enterprises must also learn foreign advanced technologies actively, especially core technologies, and transform them into the cornerstone of their own innovation.

Third, strengthen the training of talents and improve the "quality". Combine "quality" and "quantity" is a must. China is a populous country with a huge number of talents cultivated every year. In year 2020 alone, there will be 8.74 million new college graduates. However, talents entering the high-tech industry need to have more professional knowledge and more

powerful innovation capabilities. This requires further training by the enterprise to make the talent team have quality and quantity.

C. Shortcomings and prospects

First, due to the lack of data, the study year of this article is relatively short, and it does not include all provinces, cities, and autonomous regions in the country. This research model may not be sufficient to study the long-term impact of foreign direct investment on technological innovation, and may be further revised. With the improvement of statistical data and the development of analysis methods, more diversified analysis methods can be considered in the future.

Second, the choice of indicators is subjective. Although the research indicators in this article are based on previous studies, they may not be the most accurate and consistent in the selection process. Selecting R&D internal costs as an mediation variable may be insufficient. Later scholars can try to update the data and use more indicators to study this issue from other angles.

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