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The Spillover Effect of Foreign Direct Investment on China's High-Tech Industry Based on Interprovincial Panel Data

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Abstract: Since its reform and opening-up, the scale of China's utilization of foreign direct investment (FDI) has been expanding. Meanwhile, the "Belt and Road" initiative has opened up broader markets and trade opportunities for China. As a pillar industry supported by the state, the high-tech industry has also become an industry with more foreign investment. Therefore, based on the data of China's high-tech industry from 2012 to 2021, this paper analyzes the technology spillover effect of foreign direct investment on the high-tech industry in the whole country as well as in the east, west, and northeast regions by using the C-D production function. The results show that in the eastern region, FDI has a positive spillover effect on the output and technological innovation of the high-tech industry; compared with the eastern region, FDI in the central and western regions inhibits technological innovation but has a positive effect on the output of the high-tech industry; in the northeastern region, FDI hampers the output of the high-tech industry but promotes the enhancement of the technological innovation capacity. The reason for this is that FDI is unevenly distributed in each region of China, and the absorption capacity of high-tech enterprises in each region is different from that of foreign direct investment. Finally, against the background of "Belt and Road", this paper puts forward policy suggestions in light of the actual development situation of each region. China should strengthen the supervision of FDI to ensure the sustainability of foreign investment. All regions should give full play to their comparative advantages and deal with the balanced development of FDI and local factor inputs to realize the coordinated development of China's regional economy.

Keywords: FDI; high technology; technology spillover effect; technological innovation; "Belt and Road"

Citation: Zhao, M.; Chen, Q.; Dai, D.; Fan, Y.; Xie, J. The Spillover Effect of Foreign Direct Investment on China's High-Tech Industry Based on Interprovincial Panel Data. *Sustainability* **2024**, *16*, 1660. https://doi.org/10.3390/su16041660

Academic Editor: Fabrizio D'Ascenzo

Received: 18 January 2024
Revised: 12 February 2024
Accepted: 13 February 2024
Published: 17 February 2024

1. Introduction

In September 2013, China launched the Belt and Road Initiative, an international cooperation initiative aimed at strengthening connectivity and economic cooperation among partners to build a community of interests, destiny, and responsibility. With its vision of improving transportation infrastructure, the Belt and Road Initiative has had a different impact on the economic development of both developed and developing countries [1,2]. At the same time, there are implications for global trade. The outward-oriented liberalization provided by the Belt and Road Initiative brings strength to the integration of trade between Asia and Europe [3]. Reduced transportation costs have boosted trade in EU countries, but now that China has begun to establish free trade zones in the "Belt and Road" region, its trade opportunities will gradually shift to Asian countries [4]. It can be said that the Belt and Road Initiative provides a new opportunity and platform for realizing global common prosperity and balanced sustainable development. While it has had an impact on other countries, the Belt and Road Initiative has also had an impact on China itself. The Belt and Road Initiative actively mediates the willingness of partner countries to align themselves with China in international affairs and strengthens China's political position in the global order [5]. At the same time, the Belt and Road Initiative has had an impact on investment

in China. It has had a positive impact on China's outward FDI activities and has helped to solve China's domestic economic problems, but the extent of this impact depends on the willingness of host countries to participate in the Belt and Road Initiative [6,7]. Under the influence of the Belt and Road Initiative, China has gained opportunities for exchanges and cooperation with more countries, thereby attracting more foreign investment, promoting industrial transformation and upgrading in the regions along the routes, alleviating regional disparities in China, and promoting the sustainable development of the regional economy.

Foreign direct investment (FDI), as an important form of investment, has become an important policy for countries to develop their economies. Countries attract the inflow of FDI through tax concessions, incentive subsidies, land concessions, and other measures. According to the data released by the United Nations Conference on Trade and Development Organization, the United States attracted foreign direct investment amounting to about USD 285 billion in 2022, ranking first in the world, but compared with the previous year's data has decreased. The amount of foreign direct investment attracted by mainland China is about USD 189 billion, a slight increase compared with the previous year, ranking second in the world, and China continues to maintain a leading position in developing countries. It is followed by countries such as Singapore and Brazil. Through these data, it can be seen that countries have made great efforts to attract and utilize foreign investment. However, in the context of the current "Belt and Road" initiative, what impact will the entry of large amounts of foreign capital bring to their own countries? Can foreign investment contribute to the rapid development of the country's economy and technology?

Given the important role of FDI, scholars have conducted in-depth studies on it and obtained different research results. Some scholars have studied it at different levels and concluded that FDI will play a positive role in the economic development of the host country. At the country level, Ghosh found that even technologically advanced countries like the United States benefited from FDI and that the benefits of FDI were substantial in the long run [8]. Kotrajaras analyzed the impact of FDI on economic growth in 15 East Asian countries based on time-series data from 1990 to 2009 and found that FDI can have a positive impact on economic growth only in countries with appropriate economic conditions [9]. Lean's study found that FDI has a positive impact on Malaysia's economic growth [10]. Tiwari studied the impact of foreign direct investment (FDI) on the economic growth of Asian countries from 1986 to 2008 and found that FDI facilitated the growth process and that labor and capital also had an important role in growth [11]. Based on the analysis of seven Eastern European countries over the period of 1993–2008, Hudea found that FDI had an immediate and positive impact on the target countries in both the short and long term, thus contributing to the economic growth of the target countries and narrowing the technological gap with the leading countries [12]. Choong examined the relationship between FDI and economic growth in 95 developed and developing countries and found a positive correlation between FDI inflows to a country and its economic performance [13]. Zeng constructed a dynamic panel linkage equation model using China's provincial panel data from 2004 to 2016 and found that FDI has a significant positive direct impact on China's economic growth and technological innovation, and can have a significant pull effect on the domestic economy through backward spillover channels [14]. At the industry-specific level, Haskel used plant-level panel data for the UK manufacturing sector from 1973 to 1992 to obtain a robust and significant positive correlation between the activity share of foreign-owned firms and TFP [15]. Doytch found that total FDI contributed to growth at the aggregate level and that this growth was also reflected in manufacturing, but that FDI in services did not always contribute to growth [16]. Using data on 29 manufacturing industries in China's Shenzhen Special Economic Zone from 1993 to 1998, Liu found that foreign direct investment has a large and significant spillover effect, which increases both the level and productivity of the manufacturing sector and the productivity growth rate of the manufacturing sector [17]. Chakraborty found that FDI varies significantly across sectors in India and that the favorable growth of FDI in India is concentrated in the manufacturing sector, while there is no significant feedback effect in the services sector [18].

However, at the same time, there are some scholars who believe that FDI has a negative or insignificant impact on host countries. Alfaro's analysis, using cross-country data for the period of 1975–1995, yielded that the role played by FDI in promoting economic growth is ambiguous [19]. Using firm-level data from Zambia, Bwalya analyzed the nature and significance of productivity externalities of FDI to local firms and showed that there is little evidence to support productivity spillovers from foreign to local firms, which may be an adverse competitive effect of FDI [20]. Buckley, using 1995 cross-sectional data, found that multinational firms create negative spillovers but also positive spillovers to collective firms [21]. Le studies the impact of FDI on the productivity of domestic firms in Vietnam using firm-level data and found that domestic firms obtain technology spillovers through vertical linkages with foreign firms, but the horizontal presence of foreign firms harms the productivity of domestic firms [22]. Gunby obtained no significant evidence of positive spillovers from FDI at the aggregate level of China's economy using a meta-analysis [23]. Obeng-Amponsah examined data for Ghana from 1995 to 2017 and found that FDI does not affect economic growth or employment in Ghana [24].

An analysis of the literature shows that FDI brings about technological spillovers [25,26], and the impact of such spillovers on the host country is highly uncertain, depending on the following five aspects. The first is related to the absorptive capacity and investment motives of host country firms. Investment motives help to determine the type of MNE affiliation and thus the likelihood of spillovers; absorptive capacity is the ability to internalize knowledge created by others and to modify it to suit one's own particular applications, processes, and practices [27]. It is reflected not only at the microeconomic level but also at the macroeconomic level and is usually related to the level of national development [28]. FDI has a positive impact on economic growth when the host country has reached a certain minimum level of absorptive capacity [29]. The second is related to regions. The spatial characteristics of cities can have an impact on the spatial aggregation of FDI in cities [30]. The third is related to the characteristics of firms in the host country. The size of domestic firms is related to their spillover effects; small firms may not have sufficient production scales to imitate close to what TNCs introduce, and therefore larger firms may benefit from foreign firms [31]. At the same time, characteristics such as firms' ownership structures and trade orientations may also affect the size of spillovers [32]. The fourth is related to the characteristics of FDI, which include the source of FDI, the mode of entry, and the degree of foreign ownership. FDI from different countries has different technology levels and transfer patterns and may have different spillover effects on domestic firms [33,34]. When multinational enterprises enter through mergers or acquisitions, technology transfer occurs gradually, thus limiting or at least delaying spillover effects [35]. At the same time, FDI from different sources has different cultures, societies, and laws, and these differences may also have different impacts on host country firms [36]. The fifth is related to other factors. A well-developed Intellectual Property Rights (IPR) regime not only increases the likelihood that TNCs will invest but also increases the likelihood that spillovers will occur [37,38], while a weak IPR regime encourages investors to undertake projects that focus on distribution rather than local production [39]. Official visits also have a significant positive impact on FDI [40]. The introduction of new ideas allows multinational corporations to realize technological advances that lead to long-term economic growth [41].

In addition to analyzing the relationship between foreign direct investment and the economy, scholars in China and abroad have different views on whether FDI promotes technological innovation. Among them, some scholars believe that FDI has a facilitating effect on technological innovation. Fu studied the impact of FDI on the development of regional innovation capacity by using the Chinese panel dataset and found that FDI has a significant positive impact on the overall innovation capacity of the region, and the intensity of FDI is also positively correlated with the innovation efficiency of the host country [42]. Stiebale argued that FDI has increased the R&D inputs of the host country's enterprises, and thus enhanced the technological innovation efficiency of the host country's investment [43]. Erdal studied the relationship between FDI and technological innovation

in 10 developing countries in Asia from 1996 to 2013, and the results showed that the inflow of FDI will increase the R&D and innovation activities in each country [44]. Based on the micro dataset of Chinese manufacturing firms, Yue examined in detail the impacts of FDI on the innovation performance of local Chinese firms and its mechanism, and the results showed that FDI intensity is also positively related to the innovation efficiency of the host country [45]. Ali found that FDI has a positive impact on technological innovation in BRICS countries by studying FDI from 2000 to 2020 [46]. Cheung, using provincial data from 1995 to 2000, found that FDI has a positive effect on the number of domestic patent applications in China [47]. Some scholars believe that FDI has an inhibitory effect on technological innovation, and Grima found that FDI hurts the innovation activities of enterprises through industry studies [48].

In the above literature, it was found that previous literature has focused on the relationship between FDI and economic growth and technological innovation from different countries or industries. However, at present, the high-tech industry has a promotional role in economic growth and has gradually become the focus of development in various countries [49]. The existing literature lacks research on the impact of foreign direct investment in the high-tech industry. This paper mainly contributes to the following two aspects: First, China's high-tech manufacturing industry occupies a large share of FDI [50], and this paper examines the impact of FDI on China's high-tech industry from the perspectives of output value and technological innovation against the background of "Belt and Road", to provide prospective policy suggestions for China's high-quality development. Second, this paper examines whether there are significant differences in the impact of FDI on the high-tech industries in the four major economic regions of China, and if so, what the possible reasons for this are.

The rest of the paper is structured as follows: Section 2 discusses the development history of China's attraction to FDI and formulates the hypotheses. Section 3 describes the process of acquiring empirical evidence as well as the results. Section 4 presents the concluding remarks as well as recommendations for future policies.

2. China and Foreign Direct Investment

As the world's second-largest recipient of outward FDI, the development of China's FDI can be traced back to its reform and opening-up. From 1978 to the present, China's FDI has gone through four stages, as shown in Figure 1.

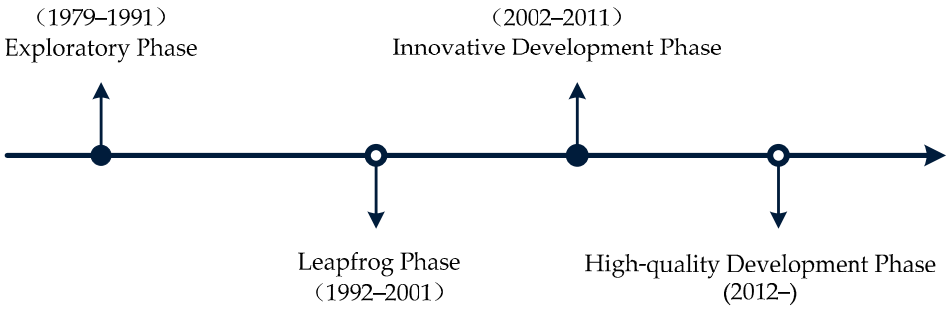

Figure 1. History of FDI development in China.

The first phase, from 1979 to 1991, was the exploratory phase of FDI in China, which began in 1978 when China shifted its focus to economic construction and started to set up special economic zones in coastal areas. However, China had a lack of experience and knowledge in attracting FDI. As a result, the inflow of FDI in China was low and stable. The years 1986 and 1988 saw the promulgation of the Law on Foreign Invested Enterprises and the Law on Chinese–International Cooperative Enterprises, which gave a series of preferential tax treatments to multinational enterprises and simplified the licensing procedures for them, thus further opening up China to the outside world. The sources of foreign investment during this period were mainly Hong Kong and Macao, while multinational corporations from the United States, Japan, Germany, and other countries

began to invest in China in the form of joint ventures [51], but China did not attract enough investment from these countries [52]. Since Guangdong and Fujian were the first to open up, the two provinces absorbed more FDI, accounting for one-third of the country's actual amount of foreign investment used. In addition, there were also foreign investment projects in central cities such as Beijing, Shanghai, and Guangzhou. Foreign direct investment at this stage was tentative, sporadic, and temporary, and it was mainly concentrated in China's eastern coastal areas, with small- and medium-sized labor-intensive processing enterprises.

The second phase, from 1992 to 2001, was the leapfrog development phase of China's FDI. In 1992, Deng Xiaoping's Southern Dialogue eliminated the political uncertainty in China and set off a new boom in FDI. China's FDI began to extend from the coast to the riverside and inland cities. In 1995, China began to emphasize the quality of foreign investment and formulated a clear industrial policy to guide foreign investment to promote the upgrading of industrial structure. At the same time, foreign direct investment was expanded to basic industries, with new wholly international-owned enterprises as the preferred entry for investment [53]. During this period, the scale of FDI fluctuated but generally showed a sharp upward trend. The 1998 Asian Financial Crisis made FDI inflows suffer a short shock, but after 2000 it entered a rapid growth phase again. At this stage, FDI had shifted from the sporadic nature of the exploratory period to a substantial, strategic, and large-scale nature.

The third phase, from 2002 to 2011, was the innovative development phase of China's foreign direct investment. China's accession to the World Trade Organization in 2001 marked a new stage in the development of China's opening up to the outside world. The rapid integration of the Chinese economy into the global economy has provided more opportunities and a better environment for multinational corporations to invest in China. As a result, even against the backdrop of the global financial crisis and the European debt crisis, MNCs' investment in China has maintained steady growth. To better adapt to the rules of international trade organizations and further attract international investment, the Chinese government adjusted existing laws and policies on international investment, expanded the opening of the service sector to the outside world, and encouraged international investors to invest in the central and western regions. In 2008, China implemented the Enterprise Income Tax Law and abolished international-related tax preferences. In terms of the scale of foreign direct investment, during the decade from 2002 to 2011, China's actual utilization of FDI amounted to nearly USD 769.167 billion.

The fourth phase is the high-quality development phase of China's FDI from 2012 to the present, when China lowered its economic growth target to improve the quality of its economic development. Therefore, even though the growth of China's FDI flows has slowed down since 2012, China is still one of the most attractive places for FDI investment in the world. In 2013, China put forward the "One Belt, One Road" cooperation initiative, which allowed more countries to recognize China's perfect infrastructure, abundant human resources, and good business environment, attracting more outbound investment. The outbreak of the New Crown Epidemic in 2019 led to a global economic recession, affecting China's foreign trade and investment. In response, China has begun to implement a double-cycle model, i.e., to build a new development pattern with a major domestic cycle as the main body and a domestic and international double cycle that promotes each other. China has focused more on building a stronger domestic market and on quality and efficiency, rather than on expanding its attraction of international investment. These initiatives have enabled China's ability to attract FDI to recover relatively quickly and remain a hot spot for global investment [54]. By analyzing the core trends of European FDI in China, it can be found that international investment has become more concentrated and directed more towards high-end technology manufacturing industries. In the decade from 2012 to 2021, the share of international investment absorbed by high-tech industries rose from 14.1% to 30.2%.

The dynamic pattern of attracting FDI in developing countries shows slow growth, followed by a longer period of fluctuation and finally a rapid growth phase [55]. By

analyzing the history of China's attraction to FDI, we similarly find that foreign direct investment in China first grows slowly, followed by fluctuating growth, and finally rapid growth. This is shown in Figure 2 below.

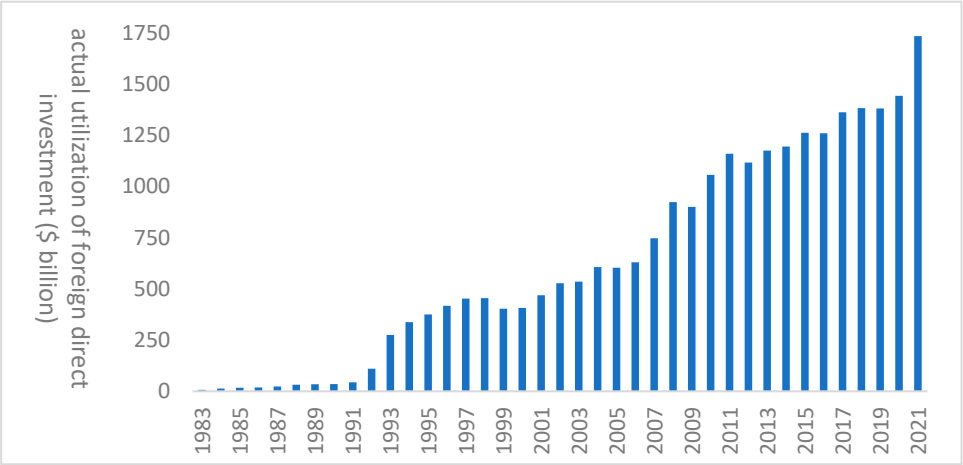

Figure 2. China's actual utilization of foreign direct investment over the years.

Currently, China's FDI is growing rapidly, and China is accelerating its shift from being factor-driven to innovation-driven. This is because host countries' comparatively advantaged industries are more attractive to FDI inflows [56], and China has a comparative advantage in high-tech activities [50]. Therefore, high-tech industries have become the focus of foreign direct investment. The entry of many international investors has brought about a spillover effect, introducing into China advanced international technology, equipment, and management experience, etc., filling the gaps in some of China's high-tech fields and thus promoting the development of China's high-tech industry. Under the "Belt and Road" initiative, this paper puts forward the hypothesis that FDI can bring positive spillover effects to China's high-tech industry, namely by the following:

Hypothesis 1a. *Foreign direct investment promotes an increase in the gross output value of China's high-tech industry.*

Hypothesis 1b. *Foreign direct investment promotes the enhancement of the technological innovation capacity of China's high-tech industry.*

3. Empirical Analyses

FDI promotes the technological progress of China's high-tech industry directly or indirectly, in which the direct way refers to the foreign-funded enterprises promoting the expansion of the host country's production of the whole industry with their development, while the indirect way refers to the spillover effect of the international-funded enterprises on the domestically funded enterprises, i.e., the international-funded enterprises invest in the host country and promote the improvement of the technological level of the local enterprises through the competition effect, the demonstration and simulation effect, the human capital effect, and the industrial correlation effect to realize the development of the whole industry.

This paper establishes an empirical model based on the Cobb–Douglas production function to analyze the impact of the spillover effect brought by FDI on domestic enterprises in high-tech industries and analyzes the empirical results and the reasons for them. Figure 3 shows the research framework of the article.

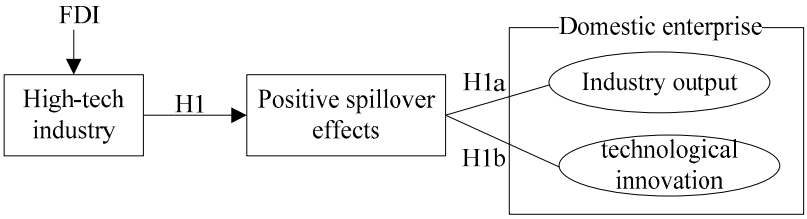

Figure 3. Research framework.

3.1. Model Construction

The model construction is based on the traditional Cobb–Douglas production function:

$$Y_t = A_t L_t^{\alpha} K_t^{\beta} \tag{1}$$

where Y_t is the firm's total output value in period t, A_t denotes technological progress and is used to measure total factor productivity TFP, L_t is the firm's labor input, and K_t is the firm's capital input. α is the output elasticity of labor, and β is the output elasticity of capital. We assume that the returns to scale of the industry remain stable, and there exists $\alpha + \beta = 1$.

To test the spillover effect of FDI, scholars introduce the *FDI* variable into the C-D production function, and there are usually two practices for the selection of FDI indicators; one is to use the absolute value of *FDI* variable and the other is to use the relative value of *FDI* variable. Some scholars internalize both the absolute and relative values of *FDI* variable into A_t when analyzing the impact of FDI on China's technological progress. This paper argues that the technological progress of domestic enterprises will be affected by direct or indirect effects; the direct effect refers to the direct effect of domestic enterprises' scientific research investment on their technological progress, and the indirect effect refers to the indirect effect brought by FDI spillovers on domestic enterprises, so the model for measuring the technological progress of domestic enterprises is established based on the new economic growth theory:

$$A_t = F(RD_t, FDI_t) = RD_t^{\mu} FDI_t^{\gamma} B_t \tag{2}$$

where RD_t is domestic enterprises' scientific research input; *FDI* is foreign direct investment in the high-tech industry; and B_t is other factors affecting technological progress. In the model of technological progress, A_t is determined by RD_t and *FDI*, and when the coefficient λ of *FDI* is zero, it indicates that FDI has no spillover effect on domestic enterprises in China; when λ is positive, it indicates that FDI has a promoting effect on the technological progress of China's high-tech industry; when λ is negative, it indicates that FDI has a hindering effect on the technological progress of China's high-tech industry.

Bringing (2) into (1) and taking into account logarithms on both sides simultaneously yields (3):

$$lnY_t = \alpha lnL_t + \beta lnK_t + \mu lnRD_t + \gamma lnFDI_t + C + u \tag{3}$$

Y_t is the total output value of domestic enterprises in the high-tech industry in period t, L_t is the annual average number of employees in the enterprises in period t, K_t is the investment amount of the enterprises in period t, and RD_t is the scientific research input of the domestic enterprises; *FDI* is the foreign direct investment in the high-tech industry, C is the constant term, and u is the error-adjustment term.

Although the model has a high degree of fit, the core explanatory variables barely pass the significance test. For further research, we corrected the model by removing the firm's investment K, to obtain Model I as

$$lnY = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \tag{4}$$

According to (4), the model of the four major economic zones in eastern, central, western, and northeastern can be obtained:

$$lnY_e = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (5)$$

$$lnY_m = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (6)$$

$$lnY_w = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (7)$$

$$lnY_{nw} = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (8)$$

To further study the role of FDI in influencing the spillover of China's high-tech industry, we selected the number of new products to represent the technological innovation capacity of enterprises; then, model II is

$$lnNP = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (9)$$

where *NP* refers to the number of new products of enterprises. If γ is positive, it indicates that FDI has a facilitating effect on improving technological innovation, and if γ is negative, it indicates that FDI has an inhibiting effect on improving technological innovation. According to Model II, we can obtain the model of the four major economic regions in the east, central, west, and northeast:

$$lnNP_e = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (10)$$

$$lnNP_m = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (11)$$

$$lnNP_w = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (12)$$

$$lnNP_{nw} = \alpha lnL + \mu lnRD + \gamma lnFDI + C + u \quad (13)$$

3.2. Data Sources

The data in this article mainly come from the China Statistical Yearbook On High Technology Industry, and for the missing 2017 China Statistical Yearbook High Technology Industry, we collected and organized the data related to the high-tech industry of each province in 2017 through the official statistical website of each region. As a result, panel data on the development of the high-tech industry in 31 provinces of China for ten years from 2012 to 2021 were obtained.

3.3. Empirical Results

3.3.1. Descriptive Statistics

Descriptive statistics for each variable for the entire sample were performed with the help of the analysis software Stata 15. According to Table 1, the mean, maximum, and minimum values of the total output value of high-tech domestic enterprises in China are CNY 258.821 billion, CNY 358.8106 billion, and CNY 770 million, indicating that there is a big gap between the total output value of high-tech domestic enterprises in different provinces in different years; the maximum and minimum values of the number of new products are 53.427 and 2, indicating that there is a gradient in the ability of new product development in different regions. Largely, the minimum value of foreign direct investment is about CNY 0 billion, indicating that the ability to attract international investment is poor in some provinces, and its standard deviation is 213.340, indicating that foreign direct investment is in a relatively stable state in various provinces of China; in terms of investment in domestic enterprises and investment in scientific research, the average values are CNY 151.9789 billion and CNY 7.79 billion, which can show the degree of importance attached by China to high-tech industry; in terms of enterprise R&D personnel investment, the maximum and minimum values are 246.659 million person years and 0.113 million person years.

Table 1. Descriptive statistics.

Variable	Obs	Mean	SD	Min	Max
Y	310	2588.210	4615.425	7.700	35,881.106
NP	310	3284.728	5844.795	2	53,427
K	310	1519.789	2444.829	2.131	20,069.231
L	310	23.400	35.200	0.113	246.659
RD	310	77.900	158.000	196.000	1340.000
FDI	310	104.617	213.340	0.000	1603.812

3.3.2. Unit Root Test

The panel data of high-tech industry in all provinces of China from 2012 to 2021 were established, and to avoid the problem of the spurious regression of the results, it was necessary to use the LLC test, the Breitung test, ADF-Fisher, IPS, PP-Fisher, and other methods to carry out the unit root test, in which the LLC and Breitung tests are for homogeneous panels, and the IPS, ADF-Fisher, and PP-Fisher tests for heterogeneous panels; when there is inconsistency in the results of different tests, the variable is considered non-stationary and one needs to continue differencing the variables until all variables are smooth in the same order of differencing. To ensure the robustness of the test results, four methods of LLC, ADF-Fisher, IPS, and PP-Fisher, which are used to conduct the unit root test for the five variables of *lnY*, *lnNP*, *lnL*, *lnRD*, and *lnFDI*, respectively, were used, and the results are shown in Table 2.

Table 2. Unit root Test.

Variable	Region	Panel Unit Root Test			
lnY	National	−14.8083 (0.0000)	123.7092 (0.0000)	−2.2515 (0.0037)	137.0494 (0.0000)
	Eastern	−7.8313 (0.0003)	45.2051 (0.0001)	−1.7368 (0.1474)	40.4197 (0.0044)
	Central	−7.4721 (0.0000)	18.1291 (0.1118)	−2.1833 (0.0522)	26.7054 (0.0085)
	Western	−8.6766 (0.0000)	46.1608 (0.0042)	−2.2217 (0.0543)	68.5891 (0.0000)
	Northwest	−4.5332 (0.0061)	15.4090 (0.0173)	−1.6712 (0.2974)	9.0271 (0.1721)
lnNP	National	−29.1250 (0.0000)	50.5308 (0.8509)	−2.4110 (0.0000)	151.7756 (0.0000)
	Eastern	−9.0777 (0.0000)	14.7076 (0.7929)	−2.2965 (0.0091)	50.6846 (0.0002)
	Central	−9.1894 (0.0000)	6.2022 (0.9055)	−2.9555 (0.0165)	23.0791 (0.0271)
	Western	−11.1621 (0.0000)	34.2400 (0.0245)	−3.8435 (0.0000)	72.0581 (0.0000)
	Northwest	−3.7855 (0.2984)	3.5985 (07308)	−2.4071 (0.0886)	10.6031 (0.1014)
lnFDI	National	−27.6710 (0.0000)	131.2361 (0.0000)	−2.2781 (0.0000)	128.3472 (0.0000)
	Eastern	−15.3277 (0.0000)	39.3160 (0.0061)	−2.1878 (0.0188)	42.2057 (0.0026)
	Central	−7.0244 (0.0009)	28.7872 (0.0042)	−1.8963 (0.1517)	30.8770 (0.0021)
	Western	−17.7633 (0.0000)	46.5112 (0.0038)	−2.3996 (0.0051)	41.6607 (0.0141)
	Northwest	−5.7263 (0.0000)	25.7436 (0.0002)	−2.1793 (0.1049)	14.1148 (0.0284)

Table 2. *Cont.*

Variable	Region	Panel Unit Root Test			
lnL	National	−15.7865 (0.0000)	106.1664 (0.0004)	−2.0400 (0.0014)	109.9562 (0.0002)
	Eastern	−10.4136 (0.0000)	29.6996 (0.0749)	−2.1054 (0.0155)	28.0350 (0.1086)
	Central	−6.6829 (0.0002)	17.9000 (0.1188)	−1.6178 (0.2887)	34.0064 (0.0007)
	Western	−9.1584 (0.0000)	48.4313 (0.0022)	−2.1796 (0.0172)	53.3033 (0.0005)
	Northwest	−4.7594 (0.0113)	11.6275 (0.0708)	−1.2240 (0.5945)	7.5422 (0.2736)
lnRD	National	−14.0224 (0.0000)	98.8961 (0.0020)	−2.1225 (0.0012)	153.4541 (0.0000)
	Eastern	−10.2441 (0.0000)	36.4020 (0.0138)	−2.0243 (0.0540)	37.0011 (0.0117)
	Central	−8.3673 (0.0000)	10.3249 (0.5875)	−2.3603 (0.0445)	27.0335 (0.0076)
	Western	−7.1068 (0.0903)	41.6656 (0.0141)	−2.4037 (0.0109)	61.7921 (0.0000)
	Northwest	−4.8825 (0.0144)	13.3147 (0.0383)	−2.4396 (0.0491)	13.5739 (0.0348)

In Table 2, from the 31 provinces in China, the variables show a smooth state under different testing methods, and the number of new products *NPs* also shows a smooth state after the first-order difference in the ADF test; for the eastern, central, and western regions, the variables show a different state (smooth or non-smooth) under different testing methods, and the results of the article on the non-smooth variables by the first-order difference show that all of them are smooth, and for the northeastern region, the total output value of the enterprise *Y*, the number of new products *NPs* are smooth after the second-order difference.

3.3.3. Cointegration Test and Regression

From the results of the unit root test, the dependent and independent variables are single-integrated in the same order, which satisfies the prerequisites of the panel cointegration test. The panel cointegration test proposed by Pedroni is used to test the east, center, west, and northeast. The results are shown in Table 3.

Table 3. Cointegration test.

Model	National	Eastern	Central	Western	Northeast
Model I		3.8380 (0.0001)	2.8748 (0.0020)	4.0081 (0.0000)	1.9893 (0.0233)
Model II	5.9516 (0.0000)	3.2396 (0.0006)	2.7973 (0.0026)	2.9107 (0.0018)	2.1395 (0.0162)

According to Table 3, there is a long-term stable relationship between *lnY*, *lnNP*, *lnL*, *lnRD*, and *lnFDI*.

The F-test and Hausman test determined that the regression results for the national, eastern, central, and western samples in Model I are estimated using a fixed-effects model, but the model is found to have serial correlation, heteroskedasticity, and cross-sectional correlation through further testing. Therefore, FGLS estimation is used to estimate the national, eastern, central, and western samples in Model I. The F-test and Hausman test determined that mixed regression estimation is used for the Northeast region. The estimation results of Model I are shown in Table 4.

Table 4. Regression results of Model I.

Variable	National FGLS	Eastern FGLS	Central FGLS	Western FGLS	Northeast OLS
lnFDI	0.014 **	0.027 ***	0.018 *	0.012 ***	−0.032 **
	(2.45)	(203.44)	(1.75)	(4.89)	(−2.24)
lnL	0.861 ***	0.691 ***	1.044 ***	0.872 ***	1.231 ***
	(39.42)	(533.44)	(17.55)	(41.75)	(41.43)
lnRD	0.137 ***	0.293 ***	0.173 ***	0.111 ***	0.034 ***
	(8.40)	(521.81)	(5.27)	(7.06)	(3.00)
Constant	−4.840 ***	−4.859 ***	−7.561 ***	−4.788 ***	−7.687 ***
	(−40.01)	(−313.17)	(−20.33)	(−92.41)	(−34.26)
Observations	310	100	60	120	30
Number of provinces	31	10	6	12	3

z-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

From the regression results of the national sample, the regression coefficient of foreign direct investment is positive and significant at the 5% level, indicating that foreign direct investment has a driving effect on the total output value of China's domestic high-tech enterprises from 2012 to 2021; that is, Hypothesis 1a is supported. Under the condition that other variables remain unchanged, the total output value of China's domestic high-tech enterprises will increase by 0.014 percentage points for every percentage point increase in FDI; the total output value of China's domestic high-tech enterprises will increase by 0.861 percentage points for every percentage point increase in the labor force; and the total output value of China's domestic high-tech enterprises will increase by 0.137 percentage points for every percentage point increase in the enterprise of scientific research investment. For every one percentage point increase in the enterprise of scientific research investment, the total output value of Chinese domestic high-tech enterprises will increase by 0.137 percentage points. Therefore, foreign direct investment no longer has a significant impact on China's high-tech industry compared to labor and research input. From the sample regression results of the eastern region, FDI is positively significant at the 1% level, indicating that FDI expands the gross output value of the high-tech industry in the eastern region, and the degree of influence is higher than the national level, the level of influence of its labor force is lower than the national level, and scientific research inputs are much higher than the national level. From the sample regression results of the central and western regions, the impact level of foreign direct investment in the central region is slightly higher than the national level, and the impact level of FDI in the west is slightly lower than the national level. Meanwhile, the impact level of labor force in the central and western regions are both higher than the national level; the impact level of scientific research inputs in the central region is slightly higher than the national level, and that of scientific research inputs in the west is slightly lower than the national level. The situation in northeast China is the opposite: foreign direct investment hurts China's high-tech industry; for every percentage point increase in foreign direct investment, the total output value of high-tech enterprises in northeast China will be reduced by 0.032 percentage points, and at the same time, scientific research inputs bring a less positive impact to the high-tech industry in northeast China. Comparing the eastern, central, western, and northeastern regions, FDI brings the greatest impact to the eastern region, followed by the central and western regions, and brings a negative impact to the northeastern region; the reason for this is that the eastern region has advantages in geographic location, culture, and economy compared to other regions, while the northeastern region is remote, and the economic structure is mainly dominated by heavy industry and traditional industries, which also indicates that there is a degree of attraction for foreign investment in China. This also shows that there is a regional effect on the degree of foreign investment attraction in China.

Using the F-test and Hausman test, it is determined that the regression results for the national and central samples are regressed using a fixed-effects model, the eastern region is regressed using a random-effects model, and the western and northeastern regions are

regressed using a mixed-effects model; however, through further testing, it is found that all of the models suffer from serial correlation, heteroskedasticity, and cross-section correlation. Therefore, Model II is estimated using the FGLS estimation method. Table 5 shows the estimation results of Model II.

Table 5. Regression results of Model II.

Variable	National FGLS	Eastern FGLS	Central FGLS	Western FGLS	Northeast FGLS
lnFDI	−0.029 ***	0.038 ***	−0.048 **	−0.075 ***	0.030 ***
	(−3.85)	(9.32)	(−2.43)	(−8.51)	(2.75)
lnL	0.309 ***	0.239 ***	0.412 ***	0.429 ***	0.274 ***
	(3.79)	(13.58)	(3.11)	(10.83)	(4.40)
lnRD	0.175 ***	0.468 ***	0.221 **	0.545 ***	0.160 ***
	(5.03)	(27.77)	(2.32)	(19.19)	(3.89)
Constant	2.141 ***	−1.090 ***	−0.617	−4.570 ***	1.541
	(2.63)	(−13.83)	(−0.39)	(−17.67)	(1.35)
Observations	310	100	60	120	30
Number of provinces	31	10	6	12	3

z-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In terms of technological innovation, foreign direct investment has a dampening effect on China's high-tech industry from a national overall perspective, i.e., it cannot be said that Hypothesis 1b can be supported. This also means that China's future innovation of high-tech industry can no longer rely on foreign forces, but to seek its development. From the point of view of the eastern region, the massive introduction of foreign capital has, to a certain extent, enhanced the technological innovation of high-tech industries in the eastern region. The regression results from the central and western regions show that FDI plays an inhibitory role in technological innovation, and this role is greater than the promotion of the total output value. For the northeast region, FDI promotes the technological innovation of high-tech industry because there is a large market demand in the northeast region.

3.3.4. Robustness Checks

To verify the reliability of the model results, a sub-sample is selected for robustness testing, and 20 provinces are randomly selected: 6 provinces in the eastern region, 4 provinces in the central region, 8 provinces in the western region, and 2 provinces in the northeastern region. The regression results of Model I and Model II are as follows.

According to Table 6 below, after randomly selecting the sub-samples for the whole country, eastern, central, and western regions, FDI has a promoting effect on the total output value of high-tech industries, while it has a suppressing effect on the total output value of high-tech industries in the northeast region. According to Table 7 below, for the whole country, central, and western regions, FDI has an inhibitory effect on the technological innovation of high-tech industries, while it has a promotional effect on the technological innovation of high-tech industries in the eastern and northeast regions. By comparing the results with those of the original model, the sign of the coefficients of the core variables are kept the same; therefore, the original model is robust.

From different country and industry levels, scholars believe that FDI has a promoting effect on the economic development of host countries [14,17]. We have the same view that FDI promotes the increase in output value of China's high-tech industry by studying China's high-tech industry.

While most of the literature suggests that FDI promotes the enhancement of technological innovation in host countries, our findings are contrary to this. This discrepancy may be caused by different research stages and research levels, which hinder the comparison between studies. We believe that FDI at this stage inhibits technological innovation in China's high-tech industries, which is the same as Sun's findings [57], but FDI shows different effects in different economic regions of China. This suggests that there are regional differences in the ability to absorb FDI.

Table 6. Robustness test of Model I.

Variable	National FGLS	Eastern FGLS	Central FGLS	Western FGLS	Northeast OLS
lnFDI	0.016 ***	0.013 *	0.038 **	0.014 ***	−0.043 ***
	(3.02)	(1.85)	(2.32)	(6.09)	(−4.60)
lnL	0.889 ***	1.351 ***	1.128 ***	0.869 ***	1.306 ***
	(59.62)	(10.06)	(8.70)	(43.07)	(19.63)
lnRD	0.120 ***	0.310 ***	0.186 ***	0.124 ***	−0.017
	(11.53)	(5.94)	(6.19)	(7.42)	(−0.29)
Constant	−4.866 ***	−21.560 ***	−8.957 ***	−4.804 ***	−7.876 ***
	(−82.66)	(−8.79)	(−5.72)	(−62.35)	(−19.41)
Observations	200	60	40	80	20
Number of provinces	20	6	4	8	2

z-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7. Robustness tests of Model II.

Variable	National FGLS	Eastern FGLS	Central FGLS	Western FGLS	Northeast FGLS
lnFDI	−0.047 ***	0.011 **	−0.089 ***	−0.071 ***	0.207 ***
	(−4.98)	(2.00)	(−3.67)	(−6.73)	(5.21)
lnL	0.492 ***	0.301 ***	0.258	0.710 ***	0.000
	(16.26)	(7.82)	(1.57)	(18.86)	(-)
lnRD	0.477 ***	0.488 ***	0.567 ***	0.317 ***	0.497 ***
	(18.81)	(11.65)	(4.56)	(9.22)	(37.74)
Constant	−4.338 ***	−1.982 ***	−2.389	−4.854 ***	0.000
	(−18.73)	(−6.66)	(−1.25)	(−19.78)	(-)
Observations	200	60	40	80	20
Number of provinces	20	6	4	8	2

z-statistics in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Previous studies have identified several determinants of FDI affecting the economic development of host countries. For example, the absorptive capacity and investment motives of the host country, the characteristics of the host country's enterprises, and the characteristics of FDI. For Chinese FDI, the market size, infrastructure, and FDI system also have an impact on it [58–60]. Therefore, to better utilize the positive role of FDI in China's high-tech industry and alleviate China's uneven regional development, China should take advantage of its regional comparative advantages and deal with the balance between FDI and local factor inputs.

4. Conclusions and Policy Recommendations

Using China's high-tech industry data from 2012 to 2021, this paper empirically examines the effect of FDI on spillovers in China's high-tech industry from the perspectives of output and technological innovation, as shown in Figures 4 and 5.

The results of the study show that: (1) FDI does not bring positive spillover effects in China as a whole; although FDI increases the gross output value of China's high-tech industries, it also significantly inhibits the ability of Chinese domestic firms to innovate in technology. (2) In the eastern region, FDI brings positive spillover effects in terms of gross output value and technological innovation, i.e., FDI significantly promotes the development of high-tech industries in the eastern region. (3) In the central region, although FDI increases the gross output value of the high-tech industry in the region, it inhibits the enhancement of the technological innovation capacity of the high-tech industry in the region. (4) In the western region, FDI significantly increases the gross output value of the region's high-tech industry, but also significantly restricts the enhancement of the skill innovation capacity of the region's high-tech industry. (5) In the northeast region, although FDI inhibits the increase in the total output value of the region's high-tech industry, it promotes the enhancement of the region's technological innovation capacity.

Figure 4. Impact of FDI on the output of high-tech industries.

Figure 5. Impact of FDI on technological innovation in high-tech industries.

By analyzing the results, we know that FDI has not brought positive spillover effects to China as a whole, or to the central, western, and northeastern regions, while it has brought positive spillover effects to the eastern region.

(1) As the eastern region has a more perfect infrastructure and developed economic system, its ability to attract foreign investment is stronger, so the eastern region can make good use of foreign direct investment, drawing on the advanced technology and management experience of international-funded enterprises. But at the same time, foreign investment will also lead Eastern enterprises to face greater competitive pressure, affecting the ability of domestic enterprises to operate independently. Therefore, when attracting foreign investment in the eastern region, it is necessary to focus on the quality of foreign investment, improve the threshold of foreign direct investment, give full play to the positive spillover effect of foreign direct investment in the high-tech industry in the eastern region, and promote the sustained and high-quality development of the eastern region of China;

(2) The central region has a convenient geographical location, which is conducive to connecting the eastern and western markets, and has greater market potential. However, the central region has limited ability to attract international investment and technology transfer, the industrial chain is relatively weak, and the synergistic ability among enterprises is low. Therefore, the central region should first strengthen the construction of the industrial chain, promote the deep integration of the high-tech industry and traditional industry, and promote the synergistic development of the upstream and downstream of the industrial chain. Secondly, as a region along the "Belt and Road", the central region should actively build the brand of a "China-European liner", build a transportation channel that communicates with domestic and international countries and connects the East, Middle East and West, deepens industrial cooperation with partners, and promotes the internationalization and development of the high-tech industry in the central region's development. Finally, the government should strengthen its guiding role in policy making, project approval, etc., and provide support for patent and technology transfer, to provide a strong policy guarantee and market environment for the development of high-tech industries;

(3) Compared with the eastern and central regions of China, the high-tech industry in the western region started late, the overall level of development is relatively low, and foreign direct investment to a certain extent impedes the local enterprises in improving the technological innovation capacity of the high-tech industry. However, the western region borders many countries along the "Belt and Road" and has rich mineral resources, ecological resources, and agricultural resources, which provide a certain material foundation for the high-tech industry. Meanwhile, the central government has given a series of policy supports in supporting the economic development of the western region, including tax incentives, innovation, and science and technology funds, which provide policy support for the development of high-tech industry. The central government should therefore continue to promote infrastructure development and establish new modern transportation and logistics hubs. The western part of the country has a very important and special position in the Belt and Road Initiative, and it should integrate the development of various modes of transportation, such as railroads, highways, and aviation. Secondly, local governments should build an all-round and multi-level opening pattern. Through cooperation with important cities and ports of the countries along the route, such as the establishment of special industrial parks, cross-border economic and trade cooperation zones, overseas trade cooperation zones, etc., should be established to promote the upgrading of industries in the west and the coordinated development of a new pattern of foreign economy and trade. Finally, local governments should cultivate and form several competitive and influential high-tech industrial clusters by regional culture and with the advantages of specialized industries to create new economic growth points;

(4) Compared with other regions in China, the economy of the northeast region is mainly based on heavy industry and traditional manufacturing, and the proportion of high-tech industry in the overall industrial structure is relatively small, and the industrial structure is relatively homogeneous. However, the northeast region has a strong

industrial base and a unique geographical location. To promote the development of high-tech industries in the northeast, local governments first need to optimize and adjust the industrial structure. The northeast region should integrate and develop high-tech industries based on traditional industries, promote the transformation and upgrading of traditional industries, and enhance the overall level of economic development. Secondly, the local government should strengthen the policy of talent introduction and cultivation, such as housing subsidies, salary, and benefits to attract local or foreign talents to return to the northeast. Finally, local enterprises should strengthen economic and trade cooperation with Russia and other northeast Asian countries, and actively participate in the China–Mongolia–Russia Economic Corridor and the construction of the "Silk Road on Ice".

This paper obtains the impact of FDI on the spillover effect of China's high-tech industry, and the results have good robustness. However, we have considered that there are some limitations to considering the spillover effect only from the perspectives of output value and technological innovation. In the future, the impact of FDI on China's high-tech industry can be analyzed from more perspectives.

Author Contributions: Conceptualization, M.Z. and Y.F.; Writing—original draft, M.Z., Q.C., D.D., Y.F. and J.X.; Writing—review and editing, D.D. and Q.C. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Key Program of the National Office of Philosophy and Social Sciences Foundation of China (Grant No. 20AJY008), the Major Program of the National Office of Philosophy and Social Sciences Foundation of China (Grant No. 20&ZD060), and the Humanities and Social Sciences Research Planning Fund of the Ministry of Education of the People's Republic of China (Grant No. 17YJA880014).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The dataset generated and analyzed in this study is not publicly available. The dataset is available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

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