

Article

Green Technology of Foreign Direct Investment on Public Health: Evidence from China

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Abstract: Nowadays, public health issues are increasingly in the spotlight, and the role played by foreign direct investment (FDI) cannot be ignored, especially in developing countries. Scholars have discussed the influencing mechanism of FDI on public health from both positive and negative aspects, but there is little literature focused on the impact of FDI's green technology spillovers. This paper explores the impact of spontaneous green technology progress induced by FDI, i.e., FDI's green technology spillover effect, on the public health status of China. It constructs a theoretical model based on the cost discovery theory and uses the Global Malmquist–Luenberger Method to calculate the green technology spillover index; then, it empirically researches the impact of this spillover effect on public health based on the Grossman health product function, using Chinese provincial data from 2007 to 2019. After a series of robustness tests, this paper also discusses the regional heterogeneity and the influencing mechanism. The main conclusions are as follows: Firstly, there is a significant negative correlation between FDI's green technology spillover and infant mortality, indicating that the spillover effect significantly promotes China's public health. Secondly, the results of regional heterogeneity show that the spillover effect of green technology presents a decreasing trend from east to west regions. The threshold effect test results also show that, when the level of economic development is extremely low or exceeds a specific threshold, FDI's green technology spillover will have a positive impact on public health. Finally, FDI's green technology spillover improves public health by controlling environmental pollution and optimizing industrial activities, but it does not worsen public health by increasing income inequality. The conclusions of this paper provide empirical support and policy suggestions for rationally and effectively utilizing FDI to promote China's public health in the future.

Keywords: foreign direct investment; green technology spillover; public health; Global Malmquist–Luenberger index; China



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1. Introduction

Foreign direct investment (FDI), defined as a cross-border investment to establish a lasting interest, makes a remarkable contribution to the economic development of the host country [1]. Information may be transferred through FDI, which also boosts the competitiveness in the national tradable sector, aids in the advancement of human capital, and generates income which is included in the hosting nation's tax collection. It also provides a source of liquidity, which helps enterprises take part in global commerce. However, while the economic effect of FDI has been widely studied, its impact on public health has been ignored for a long time [2–4]. According to the World Investment Report 2014, the most important objectives of host countries' investment incentives focus on economic benefits, such as job creation or technology transfer, while the ecological benefits account for only a small part [5]. The COVID-19 pandemic has increased awareness of public health, as the factors that may affect public health are gaining attention, and in line

with this, the impact of FDI has also begun to be valued. Data from the World Investment Report 2021 indicate that most countries have offered incentives to benefit investment in the health sector [6]. Scholars propose that FDI should be rationally used to improve the health status of the host country, especially in developing countries [7,8].

There has been a lot of research on how to improve public health from various aspects, such as industrial development or environmental protection, but very little literature focuses on the impact of FDI [9]. The nexus between FDI and public health has not been widely recognized as positive or negative. Some scholars believe that FDI would lead to environmental degradation, increased income inequality, competition, and psychological stress [10–12], which are often bad for public health. However, opponents point out that FDI could increase the supply of healthy products and increase public or private spending on healthcare [13]. Herzer et al. [2] carried out an empirical test with data from most countries of the world, and they found that the effect of FDI on public health largely depended on the host country's economic level, and that FDI in developing countries could significantly promote the domestic health status of the country. A few studies related to this issue have mentioned the role of technology spillover, but there is no consensus on its effect. Herzer [14] asserted that the technology spillover of FDI could increase the productivity of domestic sectors, thereby improving the health status of workers through higher incomes, while Li et al. [15] proposed that FDI's technology spillover damages the environment, and Burgard [16] forecasts that technological progress will lead to greater unemployment, which is bad for public health. However, few studies have gone further, linking the green technology progress brought by FDI to the public health of the host country, and the empirical analysis of typical countries and the study of its mechanism are even rarer.

As the largest developing country, China has made remarkable economic development achievements in the past decades. However, this rapid growth is largely accompanied by the uncontrolled use of natural resources and environmental pollution, which could cause damage to the health of residents [17]. To find ways to improve its public health status, this paper takes China as the research sample, focuses on the spontaneous improvement of the green technology brought by FDI, i.e., the green technology spillover effect, and studies its impact on public health. This paper constructs a theoretical model using cost discovery theory, and then conducts an empirical study with panel data for 30 provinces in China from 2007 to 2019. It calculates the green technology spillover index using the Global Malmquist–Luenberger (GML) Method, and then takes it as a core variable in the Grossman health function to assess its impact on public health. After a series of robustness tests, this paper researches the regional heterogeneity and influence mechanism of this effect. Based on the empirical results of that work, policy suggestions are finally put forward for how to improve public health in China.

The contributions of this paper are as follows: Firstly, it constructs a theoretical model of how FDI's green technology spillover affects public health in host countries, and proposes and verifies the specific transmission mechanisms, which is rarely performed in the existing literature. Secondly, the impact of FDI is shown to have a large and complex transmission mechanism, meaning that it is challenging to clarify the specific issues by taking only the amount of FDI as the explanatory variable. Different from the practice of using the stock, flow, or proportion of FDI in previous studies, this paper uses the GML method to index the green technology spillover effect of FDI and applies this index in the empirical analysis. This approach of focusing on one aspect can avoid research bias caused by the complexity of FDI's influence, thus producing more concrete and reliable conclusions.

The remainder of the article is organized as follows: the Section 2 reviews the existing literature and sets out the research hypotheses; the Section 3 introduces the research methods and data source; the Section 4 carries out an empirical regression, then discusses the regional heterogeneity and influence mechanism; and the Section 5 summarizes the conclusions and puts forward corresponding policy suggestions.

2. Literature Review and Research Hypothesis

The promotion effect of FDI on public health has been discussed from the following perspectives: Firstly, FDI could increase the supply of healthy products and services [18]. Outreville [19] pointed out that FDI makes a significant contribution to population health by improving healthcare sectors and integrating international medical services. Kumari and Sharma [20] argued that FDI in the public health sector could increase the supply capacity of medical products, reduce their prices, and thus improve public health. Secondly, FDI could increase the expenditure on healthcare by both the government and individuals. On the one hand, FDI increases the government's tax revenue, meaning its expenditure on public health will rise [2]; on the other hand, FDI could improve the productivity of domestic sectors, increase the income of workers, and thereby enhance their ability to purchase health services. Hummels [10] demonstrated how the increase in income helps to improve the health of workers. Saleem [4] proposed that the application of modern technology via FDI can improve the efficiency with which workers produce, meaning their salary and living standard could also improve, allowing them to spend more on healthcare. Thirdly, Rodrik et al. [21] asserted that FDI could increase the life expectancy of employees because of their improved working conditions. Chiappini [13] pointed out that FDI is usually associated with more advanced production technology, meaning the spillover effect can improve the environment and benefit public health.

There are also some studies that support the view that FDI is detrimental to the public health of host countries. Nguyen [22] and Paul [7] proposed that FDI would exacerbate income inequality and social inequality [23,24], and that low-income residents might experience increased stress and frustration, which lead to worse health outcomes [25], and the competitive pressure on workers in the FDI sector is usually higher [26]. In addition, the technological innovation and the crowding effect brought by FDI will also cause greater unemployment [16,27], and the economic insecurity that comes with unemployment can take a toll on the health of employees [28,29]. The increase in income brought by FDI will not only increase the expenditure on health products, but also the consumption of tobacco, drugs, and unhealthy foods, which will damage people's health [25,30,31]. At last, some scholars believe that FDI aggravates environmental pollution, which is negatively correlated with residents' health [31–33].

According to the above literature, the impact of FDI on public health is complex, but there is a relatively broad consensus that, in developing countries, it is more beneficial than harmful. Burns [1] found that increased purchasing power in developing countries could significantly improve public health. Hezer's empirical research also showed that the health promotion effect of FDI decreases with an increase in the income level [2], and because developing countries are farther away from the world's technological frontier, FDI technology spillovers play a significant role. Xu [34] and Ciruelos et al. [35] also suggested that developing countries can improve public health through access to technology spillover.

When discussing the positive influence of FDI on host countries, the technology spillover effect is hard to neglect. This effect is defined as the technological progress unconsciously produced by FDI, and it has been widely studied and verified that it could work via channels such as labor turnover, demonstration effects, competition effects, reverse engineering, and "learning and watching" [36–38]. Specifically, in terms of green technology spillover, multinational enterprises (MNEs) entering host markets would hire local workers who are exposed to environmentally friendly technology and may transfer it to domestic enterprises when changing workplace [39]. Another aspect of the promotion effect comes from the application of technology itself, MNEs' advanced technology, and efficient management, which make their products more competitive and thus raise industry standards and change consumer preferences in host countries. To survive, domestic enterprises have to seek change actively, they have to introduce more advanced production techniques that are often more health friendly, and they have to adapt to higher standards, use more efficient energy, and reduce pollution emissions [40]; in this way, the public health status of host countries could be improved. Based on the above, the first hypothesis is proposed:

H1: *The green technology spillover of FDI has a positive impact on public health.*

Since the negative relationship between environmental pollution and public health has long been agreed on in academic circles [41–43], some studies start from the impact of FDI on environmental pollution, and in that way, go on to study its impact on public health, especially in developing countries [15,31,44]. Two classical viewpoints are proposed: the Pollution Paradises Hypothesis and the Pollution Halo Hypothesis. The former argues that according to the factor endowment theory, developed countries will consciously preserve high-tech and low-pollution industries in their own territory, and move industries with opposite characteristics abroad because of the comparative advantage in sufficient labor or lax environmental regulation [45–47]. On the other hand, different from the strict environmental standards and huge fines imposed by developed countries, developing countries have not realized the importance of environmental protection, or to say, even if they have recognized the problem, they would choose to prioritize economic development; in some cases, host countries' governments would even voluntarily loose related restrictions to engage in the so-called "race to the bottom". Multinational enterprises in high-tech and low-pollution industries are forced by domestic pressures and seek reduced governance costs to gain higher profits, so they invest overseas to transfer these industries abroad, which in turn also transfer pollution and environmental damage to host countries [48–52]. Many studies support this view empirically, and some invested the ecological impact of FDI in China and confirmed the existence of this negative effect [53,54]. In contrast, the Pollution Halo Hypothesis argues that FDI could bring more advanced production technology and a mature management experience to host countries through active learning or unconscious spillover, meaning domestic enterprises can improve their energy efficiency and reduce pollution [55–58]. Zugravu-Soilita [59] insisted that foreign firms are often found to be more environmentally efficient than local firms, and Elliott and Zhou [60] also found that FDI firms from developed to developing countries are always cleaner. Kim and Adilov [61] pointed out that foreign firms might prefer to use fewer polluting technologies, as in this way, they can avoid some backlash from constituencies of their own countries. Some scholars believe that the difference between the two viewpoints is due to the heterogeneity of FDI; for example, Tang [62] pointed out that most empirical studies related to the Pollution Haven Hypothesis do not consider the heterogeneity, which is why they have different results. Hu et al. [63] found that the capital-based FDI could have a significant positive green technological spillover effect, while the labor-based FDI has a negative spillover. According to the definition of this paper, FDI's green technology spillover is the unconscious progress of the green technology generated by FDI, which highlights the positive side of FDI's impact; in other words, the FDI firms which could produce a green technology spillover effect are always characterized by technological advancement and environmental friendliness, so it is usually positive for the environmental quality, and thus, the second hypothesis is presented:

H2: *The green technology spillover of FDI could improve public health by controlling environmental pollution.*

Traditional industries, represented by heavy industry, often hurt public health [64]. An industrial structure that leans too heavily toward traditional heavy sectors is thus detrimental to public health [65], so it is necessary to improve public health by optimizing the industrial structure. According to the cost discovery theory, the entry of FDI can reveal the cost of unfamiliar investment projects, provides more product options for domestic enterprises, and expands the scope of industries that can be engaged in. Its technology spillover effect can also significantly reduce the imitation cost for domestic enterprises and improve their production efficiency, which make it easier to engage in more advanced industries [66]. On the other hand, some scholars believe that FDI will improve the efficiency and quality of green innovation in host countries, which is also conducive to the optimization and improvement of the industrial structure. Feng et al. [67] adopted panel data of China's manufacturing industries and found that the inward foreign direct

investment has a positive effect on the green innovation efficiency (GIE) of Chinese firms. Li and Zhang [68] connected the impact of FDI on green innovation in China to the environmental regulation, and they found that FDI had a positive effect in most regions of China (mainly in eastern and central regions). Song et al. [69] highlighted the technology spillovers brought by the inward FDI of China, and they believed that these spillovers could improve the green innovation capability of Chinese enterprises. According to the above literature, FDI could contribute to upgrading and optimizing the industrial structure [66,70], and the third hypothesis is proposed:

H3: *The green technology spillover of FDI could improve public health by optimizing the industrial structure.*

As productivity increases, wages for workers in the FDI sector also increase, leading to the further deterioration of income inequality in host countries, particularly in developing countries [2]. Based on the literature above, it cannot be simply judged that whether the improved quality of life, or increased purchasing power of health products, can offset the psychological stress caused by income inequality. However, the research sample is China, where due to the government macro-control and secondary distribution, the income inequality is likely to be relatively smaller, so when it comes to China specifically, the fourth hypothesis is proposed:

H4: *The green technology spillover of FDI would not hurt the public health by increasing income inequality in China.*

3. Methods and Data

3.1. Theoretical Model

In this paper, the impact of FDI green technology spillover on public health is based on the mechanism research of the literature above and the cost discovery theory of Hausmann [71]. The specific derivation process is as follows:

Assuming that every good has an exogenous world market price p , and this good is represented by a certain level of productivity θ , which is the number of units produced for a given scale of investment, we place all goods in a uniform analytical framework, where a higher commodity rank means higher productivity. The range of goods that a country can produce is defined by a continuous interval from 0 to h , that is, $\theta \in [0, h]$. h is a specific index of the skill or human capital level in the economy needed to obtain a comparative advantage; it represents the upper limit of a country's technological endowment, which can be expressed as the following function:

$$h = f(I, O, R)$$

where I represents internal knowledge, including technology research and development and human capital, O is external knowledge, including green technology spillover from trade and investment, and R represents other elements, such as the institutional quality and economic development level. Countries with a higher h value could produce more productive products. When investors are making investment decisions, they do not know whether they will end up with high- or low-productivity goods, as only after the investment is sunk can the productivity level θ associated with the investment project be discovered. Before this discovery, investors can only ensure that it is evenly distributed within the range $[0, h]$. However, once a θ associated with a specific project is discovered, it becomes common sense that others are free to produce the same good without incurring additional "discovery" costs (it is worth noting that the copycat is less productive than the incumbent, with an imitation efficiency of α). It is assumed that each investor can only undertake one project, and after discovering the productivity of the proposed project, the investor could choose to stick with this project or imitate another one. A rational investor will compare the productivity of project θ_i with the highest known productivity (θ_{Max}), so the investment decision will depend on the values of θ_i and $\alpha\theta_{Max}$ ($0 < \alpha < 1$).

Now, consider the expected profit of an investment in a specific sector, which depends on the investor's productivity and the maximum profits for others. $E(\theta_{Max})$ is an increasing function of the number of investors in the project, which is represented by m . According to the distribution hypothesis, $E(\theta_{Max})$ can be simply expressed as:

$$E(\theta_{Max}) = \frac{hm}{m+1}$$

It equals zero when $m = 0$, and it approaches the upper limit h as m approaches infinity.

Since the productivity is evenly distributed, the probability of investor i sticking to the original project is:

$$Prob(\theta_i \geq \alpha\theta_{Max}) = 1 - \frac{\alpha E(\theta_{Max})}{h} = 1 - \frac{\alpha m}{m+1}$$

which may result in the following expected benefits:

$$E(\pi | \theta_i \geq \alpha\theta_{Max}) = \frac{1}{2} p[h + \alpha E(\theta_{Max})] = \frac{1}{2} ph \left[1 + \frac{\alpha m}{m+1}\right]$$

Since $\frac{1}{2} p[h + \alpha E(\theta_{Max})]$ is the expected productivity of the project, we can approximately calculate the probability and expected return for investors mimicking other projects:

$$Prob(\theta_i < \alpha\theta_{Max}) = \frac{\alpha E(\theta_{Max})}{h} = \frac{\alpha m}{m+1}$$

$$E(\pi | \theta_i < \alpha\theta_{Max}) = \frac{1}{2} p[h + \alpha E(\theta_{Max})] = ph \left(\frac{\alpha m}{m+1}\right)$$

Combining the above formulas:

$$\begin{aligned} E(\pi) &= ph \left[\left(1 - \frac{\alpha m}{m+1}\right) \frac{1}{2} \left(1 + \frac{\alpha m}{m+1}\right) + \left(\frac{\alpha m}{m+1}\right)^2 \right] \\ &= \frac{1}{2} ph \left[1 + \left(\frac{\alpha m}{m+1}\right)^2 \right] \end{aligned} \quad (1)$$

The expected productivity of the sector is:

$$E(\theta) = \bar{\theta} = \frac{1}{2} h \left[1 + \left(\frac{\alpha m}{m+1}\right)^2 \right] \quad (2)$$

According to Formula (2), the expected productivity and profitability depend on skill endowment h , imitation efficiency α , and the number of investors involved m ; they are positively correlated with all three factors.

Now to discuss the impact of FDI's green technology spillover: according to the discussion in Section 2, the promotion effect of FDI on public health is mainly realized through increasing the supply of health products (services), increasing residents' income, and improving environmental quality. First, FDI's green technology spillover will improve the skill endowment of the host country in the form of external knowledge, meaning it increases factor h , and a wider variety of sanitary products can be produced with a higher productivity $E(\theta)$. Second, the spillover channels of FDI—including labor flow, imitation–demonstration, and cooperative R&D mechanisms—could improve the imitation efficiency α of domestic enterprises, and this would promote the application of advanced green technologies and improve the environmental quality. Finally, the inflow of FDI may increase the number of investors m , meaning more competition and productivity in the sector, and the incomes of the employees also grow. In conclusion, FDI's green technology spillover has a promoting effect on the public health of the host country.

3.2. Measurement of FDI's Green Technology Spillover

Along with continuous improvements to the productive social forces, people's demands for a high environmental quality also increase. In addition to focusing on the desirable output levels, people also increasingly pay attention to reducing pollution of the environment and other undesirable output levels [72]. To quantify and evaluate the degree of such coordinated development, scholars have conducted many studies on the total factor productivity under the constraints of resources and the environment (i.e., green total factor productivity). In the early stage, researchers commonly used the no-radial slacks-based measure (SBM) function and Malmquist–Luenberger (ML) index to evaluate the green productivity, but the ML index does not have a multiplicative property, so it could not observe the long-term growth trend of production very well. Moreover, the mixed direction of the SBM function reduced the output (both desired and undesired), potentially leading to the failure to generate a feasible solution. Therefore, this paper adopts the Global Malmquist–Luenberger (GML) Index, which is based on a series of production possibilities over the full horizon of all decision-making units [73]. The principle is as follows:

Assume that all the decision-making units are bound by the production possibility set (PPS). They use input N , $x \in R_+^N$ to produce desirable outputs M , $y \in R_+^M$ and undesirable outputs J , $b \in R_+^J$. The PPS could be expressed as follows:

$$P(x) = \{(y, b) \mid x \text{ can produce } (y, b)\} \quad (3)$$

From a computational perspective, the PPS is not useful enough, so we use the directional distance function (DDF), defining $g = (g_y, g_b)$ as a direction vector $g \in R_+^M \cdot R_+^J$. The DDF is defined as follows:

$$\bar{D}(x, y, b; g_y, g_b) = \max\{\beta : (y + \beta g_y, b - \beta g_b)\} \in P(x)\} \quad (4)$$

According to Pastor and Lovell [74], in a panel of time periods T ($t = 1, \dots$), there are two kinds of PPS: the contemporaneous one $P^t(x^t) = \{(y^t, b^t) \mid x^t \text{ can produce } (y^t, b^t)\}$ and the global one $\bar{P}^t(x^t) = P^1(x^1) \cup P^2(x^2) \cup \dots \cup P^t(x^t)$, $1 \leq t \leq T$. Accordingly, there are two corresponding vectors $\bar{D}_c$ and $\bar{D}_g$, meaning the GML index could be redefined as:

$$\text{GML} = \left[\frac{(1 + \bar{D}_g^t(x^t, y^t, b^t))(1 + \bar{D}_g^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}))}{(1 + \bar{D}_g^t(x^{t+1}, y^{t+1}, b^{t+1}))(1 + \bar{D}_g^{t+1}(x^t, y^t, b^t))} \right]^{1/2} \quad (5)$$

It can be decomposed into efficiency changes and technology changes:

$$\begin{aligned} \text{GML} &= \frac{1 + \bar{D}_g^t(x^t, y^t, b^t)}{1 + \bar{D}_g^{t+1}(x^{t+1}, y^{t+1}, b^{t+1})} \times \left[\frac{(1 + \bar{D}_g^{t+1}(x^t, y^t, b^t))(1 + \bar{D}_g^t(x^{t+1}, y^{t+1}, b^{t+1}))}{(1 + \bar{D}_g^t(x^{t+1}, y^{t+1}, b^{t+1}))(1 + \bar{D}_g^{t+1}(x^t, y^t, b^t))} \right]^{1/2} \\ &= \text{EC} \times \text{TC} \end{aligned} \quad (6)$$

where the efficiency change (EC) represents the movement of a decision-making unit towards the best practice frontier, and technology change (TC) represents the technology progress; when the TC is greater than 1, it can be considered that the inputs used in the measurement could promote technology progress, and vice versa.

The Global Malmquist–Luenberger Method includes three levels of the index system: (a) An input indicator, including the provincial stock of foreign direct investments, energy consumption, and labor force. (b) An expected output indicator, expressed by the GDP of each province. (c) Undesired output indicators, including the emissions of CO₂, SO₂, wastewater, and smoke dust. Measurement details are given in Table 1, and the data were collected from China's statistical yearbooks and the Carbon Emission Account Datasets (CEADs). By processing the above data using Stata software, the GTFP and the decomposed technology change can be obtained, and the latter could represent the green technology spillover of FDI.

Table 1. Measurement details of GML.

Type	Variable	Detail
Input	Capital	Amount of foreign direct investment actually utilized.
	Energy	Electricity consumption.
	Labor	Number of employed people at the end of year.
Desirable Output	GDP	
Undesirable Output	CO ₂ emission	Industrial pollutants emission.
	SO ₂ emission	
	Smoke dust emission	
	Wastewater emission	

3.3. Setting of the Research Model

When studying issues related to public health, scholars usually build research models based on the Grossman health production function [75]. The function includes income, health, the environment, government behavior, and other factors, showing that the health statuses of residents are not only affected by the environment, but are also influenced by many other factors. This paper introduces FDI's green technology spillover as a core explanatory variable in this function and constructed the following model with panel data:

$$Health_{it} = \beta_0 + \beta_1 GTC_{it} + \beta X_{it} + \varphi_i + \psi_t + \varepsilon_{it} \quad (7)$$

In this model, $Health_{it}$ represents the public health status, GTC_{it} is the green technology spillover calculated above, X_{it} is a series of control variables, φ_i and ψ_t control the fixed effects of the country and time, respectively, and ε_{it} is the error term.

3.4. Variables and Data Source

Based on the existing literature [4,13], the perinatal mortality rate of each province is selected as the core explanatory variable; generally speaking, it is inversely proportional to the local public health. The other control variables that might influence public health include the economic development level (ED), the medical infrastructure construction (IC), the government's expenditure on health (GE), the density of the population (DP), and the urbanization level (UI). The data source and details are shown in Table 2, and the descriptive statistics of the variables are shown in Table 3. Limited by data availability, this paper uses the panel data for 30 provinces (due to data availability and consistency considerations, Hong Kong, Macao, Taiwan, and Tibet were not included, which is also a common practice in relative studies) from 2007 to 2019. To reduce the influence of the data magnitude, the corresponding indexes were logarithmically processed.

Table 2. Data source and details.

Variable	Definition	Data Source
Dependent variable <i>Health</i>	The perinatal mortality rate.	China Health Statistics Yearbook
Explanatory variable <i>GTC</i>	The province-level green technology spillover of FDI.	Calculation above
Control variable <i>ED</i>	GDP per capita (logarithmic form).	China Health Statistics Yearbook China Statistical Yearbook
<i>IC</i>	Number of beds in medical institutions per 100,000 population (logarithmic form).	
<i>GE</i>	Government's expenditure on public health as a percentage of GDP.	
<i>DP</i>	The density of population.	
<i>UI</i>	The urban population proportion.	

Table 3. Sample statistical results of each variable.

Variable	Obs	Mean	Std.Dev.	Min	Max
<i>Health</i>	390	6.495	2.931	1.811	19.17
<i>GTC</i>	390	1.127	0.155	0.665	1.743
<i>ED</i>	390	1.326	0.559	−0.243	2.784
<i>IC</i>	390	0.043	0.039	0.011	0.180
<i>GE</i>	390	0.017	0.008	0.004	0.052
<i>DP</i>	390	4.623	6.758	0.046	38.839
<i>UI</i>	390	0.547	0.138	0.227	0.896

4. Empirical Results

4.1. Benchmark Empirical Results

Firstly, the regression was performed with the model of Equation (7), and the results are shown in Table 4. Column (1) gives the results for a basic regression, column (2) adds control variables, and column (3) controls individual and time effects.

Table 4. Results of the benchmark regression.

Variable	(1)	(2)	(3)
<i>GTC_{it}</i>	−0.167 *** (−3.11)	−0.138 *** (−3.23)	−0.127 *** (−3.77)
<i>ED</i>		−4.079 *** (−2.63)	−5.078 ** (−2.73)
<i>IC</i>		−2.466 *** (−3.14)	−2.491 *** (−3.36)
<i>GE</i>		−5.495 *** (−7.11)	−7.114 *** (−7.62)
<i>DP</i>		−0.0007 (1.38)	−0.0001 (1.66)
<i>UI</i>		0.062 * (2.11)	0.057 * (2.08)
<i>fixed effect</i>	No	No	Yes
<i>obs</i>	390	390	390
<i>R²</i>	0.54	0.55	0.54

Note: *t*-values are in parentheses; *, **, and *** mean significant at the significance level of 10%, 5%, and 1%, respectively.

The following conclusions can be drawn: (a) The coefficient of the core explanatory variable, *GTC_{it}*, decreases after introducing other control variables and fixed effects, but it is consistently negative at the 1% significance level, indicating that the increase in FDI's green technology spillover effectively reduces perinatal mortality, which could be translated into the improvement of public health. Specifically, every 1% increase in green technology spillover of FDI could produce a 0.127% increase in public health quality. (b) The levels of economic development, medical infrastructure construction, and government expenditure on public health are also negatively correlated with perinatal mortality, indicating that the growth of the economy, improvement of medical facilities, and increase in government spending have positive impacts on public health, which fits the general understanding, that is, the higher level of economic development or government management ability will promote the improvement of public health quality. (c) The urbanization level is significantly positive at the 10% level, indicating that an increasing level of urbanization will reduce the quality of public health, which may be partly due to the lack of medical services and lower environmental quality in overcrowded cities. (d) The impact of population density on public health is not significant; this is an interesting result, perhaps because the effects of population density are too complex.

4.2. Robustness Test

To enhance the reliability of those conclusions, this paper adopted two robustness tests. Firstly, provincial panel mortality data were used instead of perinatal mortality as an explanatory variable, and the benchmark regression was performed again; the results are reported in column (1) of Table 5. Secondly, this paper used the Poisson pseudo maximum likelihood (PPML) method to estimate the equation, and the results of that work are reported in column (2) of Table 5.

Table 5. Results of the robustness test.

Variable	(1)	(2)	(3)	(4)
<i>GTC</i>	−0.023 ** (−2.32)	−0.188 *** (−3.61)		
<i>Patent</i>				−0.023 ** (−2.32)
<i>ED</i>	−2.987 ** (−2.35)	−2.278 ** (−2.50)		−1.312 ** (−2.35)
<i>IC</i>	3.878 (0.62)	−2.676 *** (−3.24)		−1.255 ** (2.88)
<i>GE</i>	−15.262 * (−1.97)	−5.287 *** (−3.12)		−7.329 * (−2.11)
<i>DP</i>	−0.001 *** (−3.63)	0.001 (0.06)		−0.000 (−0.23)
<i>UI</i>	−0.049 (−0.67)	0.078 * (1.82)		0.055 * (2.17)
<i>GTC_{t−1}</i>			−0.258 *** (−4.33)	
<i>ED_{t−1}</i>			−3.224 ** (−3.15)	
<i>IC_{t−1}</i>			−2.519 *** (−2.87)	
<i>GE_{t−1}</i>			−1.146 *** (−2.98)	
<i>DP_{t−1}</i>			−0.015 (0.77)	
<i>UI_{t−1}</i>			0.102 * (1.98)	
<i>fixed effect</i>	Yes	Yes	Yes	Yes
<i>obs</i>	390	390	390	390
<i>R²</i>	0.62	0.53	0.48	0.56

Note: *t*-values are in parentheses; *, **, and *** mean significant at the significance level of 10%, 5%, and 1%, respectively.

Alsan [76] and Nawaz et al. [77] studied the relationship between FDI and public health from opposite paths. They found that foreign investors are more likely to invest in areas with better public health conditions, meaning that these areas are more likely to benefit from green technology spillover effects. This reverse causality in study may have led to an endogenous bias. To cope with the reverse causality, two methods were added: firstly, the lag terms of *GTC* and other control variables were introduced, which could not be affected by the current health status. Secondly, the number of green invention patents (*Patent*) in each province was adopted as an instrumental variable; it is closely related to the green technology spillover of FDI but has nothing to do with public health. After processing the data, the regression was reperformed, and the results of this work are reported in columns (3) and (4) of Table 5.

It can be seen that after the change in variables or regression methods, the results were basically the same; therefore, the research conclusion can be considered robust. Moreover, the result in column (3) also shows that FDI's green technology spillover had a persistent lag effect on public health.

4.3. Heterogeneity Test

Due to China's vast territory, provinces in different regions have different characteristics. To further explore the status of each region, this paper divided the 30 provinces into eastern, central, and western regions. After performing a grouping regression including control variables and time-individual fixed effects, the results of which are reported in Table 6, it can be noted that the impact of FDI's green technology spillover showed a decreasing trend from east to west, and this may have been related to the distribution of FDI itself, which has a strong regional heterogeneity. FDI in the eastern region was superior to other regions both in quantity and quality, while FDI in the western region played a relatively limited role. The coefficients of other control variables were mostly insignificantly different from those of the benchmark regression, and the only thing worth noting is that there was a significant positive correlation between population density and public health in the western region, which may have been related to the relatively sparse and under-developed population in the western region, as the areas with high population densities are mostly large- and medium-sized cities with better medical and health conditions. This special case also partly explains why the population density variable in the benchmark regression did not have a significant impact.

Table 6. Results of the heterogeneity.

Variable	Eastern	Location Central	Western
<i>GTC</i>	−0.054 *** (−3.44)	−0.062 ** (−2.09)	−0.126 (−1.40)
<i>ED</i>	−1.797 *** (−2.21)	−2.096 * (−1.82)	−1.157 ** (−1.99)
<i>IC</i>	−0.041 ** (−1.81)	−0.147 * (−1.87)	−0.189 *** (−2.64)
<i>GE</i>	−0.157 *** (−5.20)	0.044 (1.04)	−0.229 ** (−2.44)
<i>DP</i>	0.026 (1.21)	0.017 (1.13)	−0.147 *** (−3.36)
<i>UI</i>	0.003 (0.15)	0.034 ** (2.18)	0.046 ** (2.55)
<i>control</i>	Yes	Yes	Yes
<i>fixed effect</i>	Yes	Yes	Yes
<i>obs</i>	143	117	130
<i>R</i> ²	0.95	0.95	0.94

Note: *t*-values are in parentheses; *, **, and *** mean significant at the significance level of 10%, 5%, and 1%, respectively.

As China's economic development level is high in the east and low in the west, the promotion of FDI's green technology spillover to public health in China may be directly proportional to the economic development level, though this is contrary to the research conclusion of Herzer et al. [1,2]. To delve into this, this paper constructed a threshold variable model with the per capita income (logarithmic form) of each province as the threshold index. The results of the threshold test showed that it passed the two-threshold hypothesis, but it did not meet the conditions of the three-threshold hypothesis, indicating that there were two threshold values in the model (The *F* value of the two-threshold model test was 9.952 ** (*p*: 0.030), and the *F* value of the three-threshold model test was −0.000 (*p*: 0.980), so the two-threshold model was adopted). The empirical results are reported in Table 7. It can be seen that when the per capita income was extremely low, FDI's green technology spillover had a positive and significant impact on public health (effectively reducing infant mortality), but only a few samples fell below this threshold (all were western provinces and in earlier years). When the per capita income crossed the first threshold, the role of green technology spillovers became less obvious, until it crossed the second threshold.

Table 7. Results of the threshold test.

Variable	Coefficient	Standard Deviation	t Statistics
<i>GTC (income < 9.649)</i>	−0.184 ***	0.509	−3.60
<i>GTC (9.649 ≤ income < 10.536)</i>	−0.032	0.370	−0.86
<i>GTC (10.536 < income)</i>	−0.194 ***	0.466	−4.17
<i>ED</i>	−3.875 ***	0.311	−12.47
<i>IC</i>	−1.019 ***	0.126	−8.06
<i>GE</i>	−6.500 ***	0.992	−3.68
<i>DP</i>	−0.002 ***	0.001	−9.55
<i>UI</i>	0.086 **	0.016	2.46

Note: *t*-values are in parentheses; **, and *** mean significant at the significance level of 5%, and 1%, respectively.

This result indicates that, in China, the effect of FDI's green technology spillover on public health is more obvious in provinces with higher levels of economic development. A possible explanation for this difference from previous studies is as follows: previous studies took FDI as the core explanatory variable, and the role of FDI in providing health products or increasing residents' purchasing power was indeed more obvious in low-income areas. However, the starting point of this study was the green technology spillover of FDI, that is, its impact on the progress of green technology in host countries. Such technology spillover has higher requirements for the technology absorption capacity of domestic enterprises, which is usually related to the original level of economic development. Therefore, in the eastern regions with a relatively developed economic level, FDI's green technology spillover plays a greater role in promoting public health.

4.4. Influence Mechanism

To verify the hypothesis on the influence mechanism proposed above, this paper constructed a mediating effect model as follows:

$$Mediator_{it} = \alpha_0 + \alpha_1 GTC_{it} + \alpha X_{it} + \varphi'_i + \psi'_t + \varepsilon'_{it} \quad (8)$$

$$Health_{it} = \theta_0 + \theta_1 GTC_{it} + \theta_2 Mediator_{it} + \theta X_{it} + \varphi_i + \psi_t + \varepsilon_{it} \quad (9)$$

where $Mediator_{it}$ is the proxy variable for the mechanism described above, coefficient α_1 in Equation (8) represents the influence of FDI's green technology spillover on the proxy variable, and coefficient θ_2 in Equation (9) represents the mediating effect of the proxy variable on public health, and the other terms are the same as in Equation (7). The annual mean value of PM2.5 in each province was selected to represent the environmental pollution, and the data came from the Atmospheric Composition Analysis Group of Washington University in St. Louis, MO, USA. The Theil index was calculated for each province to measure the rationalization of the industrial structure, and the data came from China's statistical yearbooks. The Gini coefficient of each province was used to measure the income inequality, and the data came from each province's statistical yearbook.

The empirical results of the mediation effect model are reported in Table 8. The first row reports the regression results of Equation (8), indicating that the green technology spillover of FDI had a significant impact on environmental pollution and the industrial structure. To be specific, it helped reduce the PM2.5 and decrease the Theil index, which is inversely proportional to the rationalization of the industrial structure. The last column indicates that FDI's green technology spillover had no significant impact on income inequality. The second row reports the regression results of Equation (9), and the coefficients of all the columns were significantly positive, indicating that both environmental pollution and income inequality could damage public health, but the optimization of the industrial structure played a positive role. From what has been discussed above, the hypotheses have been verified: the green technology spillover of FDI can improve public health by controlling environmental pollution and optimizing the industrial structure, and it may not necessarily have a negative impact by increasing income inequality.

Table 8. Results of the influence mechanism test.

	(1)	(2)	(3)
Variable	Environmental Pollution	Rationalization of Industrial Structure	Income Inequality
<i>GTC</i>	−0.117 ** (−2.21)	−0.469 *** (−4.90)	0.538 (0.66)
<i>Mediator</i>	0.068 *** (4.37)	0.173 *** (2.87)	1.025 * (1.83)
<i>control</i>	Yes	Yes	Yes
<i>fixed effect</i>	Yes	Yes	Yes
<i>obs</i>	390	390	390

Note: *t*-values are in parentheses; *, **, and *** mean significant at the significance level of 10%, 5%, and 1%, respectively.

5. Conclusions

This paper explores the impact of spontaneous green technology progress induced by FDI, i.e., FDI's green technology spillover, on the public health status of China. It also summarizes the positive and negative mechanisms of FDI's impact through the existing literature and constructs a model of FDI's green technology spillover effect on public health based on the cost discovery theory. It uses the Global Malmquist–Luenberger Method to calculate the green technology spillover index at the provincial level, then empirically researches the impact of this spillover effect on public health based on the Grossman health product function. After a series of robustness tests, this paper discusses the regional heterogeneity and influencing mechanism. The main conclusions are as follows: Firstly, there was a significant negative correlation between FDI's green technology spillover and infant mortality, indicating that the spillover significantly promoted public health in China. Secondly, the results for regional heterogeneity showed that the spillover effect of green technology presented a decreasing trend from east to west, and the threshold effect test results also showed that when the level of economic development was extremely low or exceeded a specific threshold, FDI's green technology spillover had a positive impact on public health. Finally, FDI's green technology spillover improved public health by controlling environmental pollution and optimizing the industrial structure, and it may not necessarily deteriorate public health by increasing income inequality.

To rationally and effectively utilize FDI to promote China's public health, here are some policy suggestions: Firstly, the government should not only consider the economic effect of FDI, but also consider the impact on public health, and it should not only consider the quantity of FDI, but also consider its quality. Accordingly, the government should strive to introduce foreign investment with a higher green technology content. Secondly, different strategies should be formulated according to the levels of economic development and foreign investment in different regions; for example, the eastern and central regions with sufficient FDI inflows could prioritize optimizing the FDI quality, such as raising environmental or technology standards in attracting foreign investment, while the western regions could focus on attracting more FDI and pursuing a spillover effect. Finally, improving the environmental quality and optimizing the industrial structure are effective ways for FDI's green technology spillover to improve public health, and related policies of reducing pollution or upgrading the industrial structure can be adopted to amplify these effects and thereby support the coordinated development of the economy and public health.

Limited by academic level and data acquisition, this paper only studies the impact of FDI green technology spillovers on Chinese residents' public health in a general sense but lacks further research on heterogeneity and impact mechanisms. For example, grouping sample provinces according to geographical location alone is not very ideal, and there are still many other possible hypotheses about the mechanisms of influence factors, some of which may even lead to opposite conclusions. As for why the relationship between the influence effect and economic development level is different from existing research,

this paper only makes a conjecture, and fails to explain it from an empirical perspective. Moreover, there is no discussion of whether the significance of influence mechanisms, such as income inequality, is generally applicable to other developing countries. These limitations will be further improved in the future. In addition, according to the results of the mechanism test, although the impact of FDI green technology spillover on this is not apparent, income inequality has the potential to significantly damage public health, and thus great attention should be paid to further investigating this effect in future research. Meanwhile, the measurement of the green technology spillover index of this paper can also be applied to research on other issues, such as green innovation or sustainable development.

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