Abstract: The outbreak of COVID-19 has had an immeasurable impact on the global economy. It has damaged parts of the real economy, but also provided new opportunities for China’s green development. Both the system and foreign direct investment (FDI) have an important impact on China’s green recovery path. Based on the provincial panel data of China from 2007 to 2016, this paper uses a slacks-based measure (SBM) model and Malmquist–Luenberger (ML) index to measure the green total factor productivity (GTFP), and empirically analyzes the regulatory role of system in the influencing mechanism of FDI on GTFP. The results show that the overall level of FDI significantly inhibits the improvement of GTFP, and the interaction between system and FDI makes it shift from inhibition to promotion, but the promotion would be weakened with the improvement of the system. FDI in the eastern region shows a positive effect on GTFP, which will be weakened with the improvement of the system. FDI in central and western regions shows a negative effect on GTFP, and the negative effect in western regions will be increased with the improvement of the system. Then this article puts forward targeted policy suggestions for further improving the level of regional systems and introducing FDI of high quality.

Keywords: foreign direct investment; system; green total factor productivity; regulating effect

1. Introduction

In the context of the spread of the epidemic, the global economic development situation is grim. Domestically, China’s economy and society have been affected to a certain degree, but they are gradually recovering and have achieved periodic and decisive victories. All these benefit from China’s open political measures, sound economic foundation and business environment. No matter what the Chinese Communist Party proposed to build a higher-level open economy system in the Fourth Plenary Session of the 19th CPC Central Committee before the outbreak of the epidemic, or President Jinping Xi pointed out that all countries should seize the historic opportunity to promote the “Green Recovery” of the world economy after the outbreak of the epidemic [1], they all emphasize the urgency of developing a green economy.

The concept of green economy has become a significant field in the specific development policies of countries around the world [2]. It was first proposed by the British environmentalist Pearce in the book *Blueprint for a Green Economy*. He believed that green economy is a form of economic development opposed to the traditional pursuit of economic growth. It emphasizes the organic combination of social development and ecological environment protection [3]. Since then, the concept has continued to expand. The United Nations Environment Programme has defined green economy as an economy that improves human well-being and social equity, while significantly reducing environmental risks and ecological shortages [4]. Referring to this definition, most current studies believe that green economy is a sustainable development model that seeks low carbon and energy
efficiency while considering social equity [5,6]. The development of green economy focuses not only on economic “quantity”, but the joint improvement of economic “quality” and “quantity”. That involves eventually realizing the coordination of economic development with environmental protection, resource utilization and social progress [7,8]. However, China’s long-term dependence on an extensive economic growth model has become a bottleneck restricting sustainable development. We urgently need to pay attention to the warning issued by nature and explore a sustainable green development model with ecological protection and economic recovery. In addition, as the epidemic continues, it is necessary to rebuild the balance between economy and environment. Green total factor productivity (GTFP) is an indicator that can consider economic growth and environmental pollution at the same time, and represents the level of development of the green economy to a certain degree [9,10]. Thus, improving GTFP has become an important way for China to comprehensively build an environment-friendly society and realize economic “Green Recovery”.

With the continuous advancement of economic globalization, FDI has become an important source of economic growth in China [11]. According to the data of the China Statistics Bureau, China’s actual utilized foreign direct investment had reached 138.14 billion dollars by 2019, a 148-fold increase compared to less than 1 billion dollars in the initial period of reform and opening up. Since the outbreak of the epidemic, the global cross-border investment has shown a downward trend, however, China’s absorption of foreign investment drew a bright U-shaped arc. In the first quarter of 2020, China’s actual utilized foreign capital decreased by 10.8% year over year, but picked up in the second quarter, achieving a year-on-year growth of 8.4%. Meanwhile, China’s economy is picking up, with GDP down 6.8% in the first quarter and up 3.2% in the second. All these measures indicate that FDI still plays a significant role in China’s economic development.

In addition, the basic market system of the host country is an important foundation for FDI to function [12]. However, due to China’s vast territory and uneven regional development, the level of institutional development, the amount and composition of FDI are also different in different regions [13]. Wei and Zhang used a factor analysis method to calculate the value of institutional environment of China’s provinces from 2001 to 2015. Generally speaking, the institutional environment of each province has improved year by year. The comprehensive value of most provinces in the eastern region exceeds the average value, while the central and western regions lag behind the east [14]. In the study of the relationship between system and regional output efficiency, Cen and Jiang also found that the level of system development in China has spatial differences. On the whole, it is relatively high in the eastern coastal areas, and gradually decreases in the central and western regions [15]. For different regions, FDI also shows large differences, which is mainly reflected in the amount of FDI introduced. According to the data released by the Ministry of Commerce over the years, the imported FDI in China is mainly concentrated in the eastern region, accounting for more than 80% of China’s total.

By combing the exiting literatures on FDI and green total factor productivity, it can be seen that the current conclusions are mainly divided into two aspects. First, FDI has promoted the improvement of GTFP, mainly through technology spillovers [16–20]. On the other hand, many scholars have come to the conclusion that FDI shows an inhibitory effect on GTFP [21–24]. Moreover, in the early 20th century, many scholars have studied the relationship between the institutional environment and FDI [25–27]. However, under the influence of the system, the impact of FDI on the green development of different regions is still unclear. The existing literature has definite reference significance, but there is still room for expansion. First, in the research on FDI and GTFP, few documents consider the role of institutional factors in this influencing mechanism. Second, most studies only consider the quantitative characteristics of FDI and measure FDI based on the ratio of the actual use of foreign direct investment to GDP, ignoring the quality characteristics of FDI and failing to reflect its actual level.
In summary, China’s green development in the post-epidemic era will face greater challenges and gain more opportunities. However, as FDI and system are important factors in green development, their mechanism and effects need to be further explored. Based on the theoretical analysis of FDI and green total factor productivity, this paper further introduces institutional factors to analyze the influence of FDI on GTFP under the effect of the system. In addition, this research constructs a comprehensive index system that considers both the quantitative and qualitative characteristics of FDI to measure the actual level of FDI, avoiding the use of FDI that only considered quantitative characteristics and distorting its impact on GTFP.

2. Mechanism Analysis

Based on existing studies, this article believes that the influence mechanism among system, FDI and GTFP can be intuitively represented by Figure 1.

![Figure 1. The mechanism of FDI, system and GTFP [28–35].](image)

2.1. The Action Mechanism of FDI on GTFP

According to the theory of international direct investment, FDI is an activity of transferring comprehensive elements of international enterprises. These elements mainly affect the enterprises of the host country through four channels: imitation-demonstration, technical personnel flow, competition effect and industrial association effect [28]. First, the technology gap between the home country of FDI and the host country is proportional to the technology diffusion rate [36]. Therefore, the introduction of multinational enterprises with advanced technologies will help domestic enterprises learn and imitate, thereby improving production efficiency and reducing energy consumption and environmental emissions. Secondly, the introduction of foreign capital often brings high-tech personnel, strengthening the flow of human capital between multinational and domestic enterprises, which is conducive to the exchange and learning of high-tech knowledge. However, it may also rob the technical talents owned by the host country enterprises by providing high salaries, leading to a shortage of technical innovation personnel, which is harmful to technological progress. Third, there will be a competitive effect between transnational and domestic enterprises, which can motivate host country enterprises to carry out technological innovation actively and independently. In contrast, FDI may also occupy a large market share and form a monopoly with its advantages, which is bad for the survival and development of local enterprises. Finally, foreign-invested enterprises can establish value and industrial chain with local enterprises, which accelerates the spillover of knowledge and technology from developed areas to less developed areas. The hypothesis of “Pollution Heaven” of FDI that has attracted much attention recently also shows that the transfer of low-value-added, high-polluting, and high-energy consumption enterprises from developed countries to developing countries has an increasingly prominent hindering effect on the improvement of GTFP [37,38]. Therefore, the role of FDI in promoting GTFP needs to be further studied.
2.2. The Mechanism of System Affecting GTFP

The system is a concept with rich connotation, which involves various aspects of government, the market economy and law [29]. Therefore, we can analyze the mechanism of institutional factors on GTFP from the following three aspects: (1) Political control. Excessive government control is not conducive to the enthusiasm of domestic enterprises’ research and development (R&D) investment and the improvement of independent innovation capabilities. Even if the cost of technology learning is not high, it cannot play its positive externality and turn it into technology accumulation. However, the government’s policy intervention may control energy consumption and pollutant emission, thus promoting the GTFP [30]. (2) Market system. Sound market system and perfect competition mechanism can evaluate the market value of technological innovation correctly, and make it get the attention of enterprises. Nevertheless, China’s market is mainly divided by administration, and the efficiency of factor allocation is not high, which inhibits the creativity of the whole economy. XIE’s research found that the distortion of the factor market significantly inhibited the increase of GTFP [31]. At the same time, the loose market system and open business environment may also introduce a large number of investments with high pollution and energy consumption, which has a negative effect on the local green total factor productivity. (3) Legal system. The influence of the legal system on GTFP is mainly reflected in intellectual property protection and environmental regulation. Patent protection systems can encourage independent R&D of enterprises, reduce the risk for R&D, and benefit technological innovation and sustainable economic development. The implementation of a reasonable environmental regulation system will have a certain positive effect on the improvement of the environment [32]. However, China often does not pay enough attention to the control of environmental pollution in the process of economic development. Therefore, the influence of systematic environment on GTFP also needs to be verified.

2.3. The Influence Mechanism of FDI on GTFP under the Effect of System

The process of FDI affecting GTFP needs the support of a certain external environment. As an important part of the external environment, systems may have a significant regulatory role [33]. First of all, countries or regions with high institutional levels have lower market access thresholds and greater economic freedom, which can attract amounts of FDI. The lower market access threshold may lead to a large influx of foreign enterprises with high pollution and energy consumption, and it shows a negative effect on the quality of FDI. Yu and Li used panel data of 30 provinces in China from 2009 to 2018 to study the impact of different types of environmental regulatory policies on the quality of FDI. The results showed that strengthening environmental regulatory policies can improve the quality of FDI and avoid China becoming a “Pollution Heaven” for FDI [34]. Furthermore, in a complete market economic system environment, the efficiency of resource allocation is relatively high, and the transaction costs in economic activities are also smaller. FDI tends to invest in areas with a higher level of marketization. Secondly, the host country’s enterprises must have the ability to accept, absorb and digest the technology of foreign enterprises. Countries or regions with well-established systems often have complete talent training and knowledge reserve systems. Moreover, the mobility of human capital is also relatively strong. Therefore, local enterprises can better learn and absorb high and new technology and are easier to innovate, which reflects the positive effect of the system on the quality of FDI. For example, Nishioka and Ripoll concluded that the positive externality spillover of external spatial knowledge was based on an excellent institutional environment through empirical research. Otherwise, there might be a phenomenon of “reverse flow” of technological resources to foreign-funded department [35]. Finally, under a high degree of marketization and a complete legal system, FDI will invest more in high-tech industry. This is not only conducive to the more efficient spillover of foreign enterprises’ high-tech and advanced management experience but also reduces the uncertainty of core technology in the process of dissemination and the crowding-out effect on domestic technology. All these
reflect the positive effect of the system on the quantity of FDI. In conclusion, the regulatory role of system in the mechanism of FDI on GTFP is unknown and needs further verification.

3. Model, Variables and Data
3.1. Model Setting

Based on the new growth theory, this paper draws on the research results of Miller and Upadhyay [39], assuming that openness, trade orientation and human capital can impact total factor productivity (TFP). Drawing on their ideas, this article constructs the following production function:

\[ Y = A(open, HC, t)F(K, L) \]  

(1)

where \( Y \) is the GDP, \( open \) is the openness to the outside world, \( HC \) is the human capital, \( K \) is the amount of capital input, and \( L \) is the amount of labor input. \( A(\cdot) \) represents the Hicks-neutral efficiency function of technological progress.

Based on theoretical analysis of this article, this study adds \( FDI \) to Equation (1) and obtains the following function:

\[ Y = A(FDI, open, HC, t)F(K, L) \]  

(2)

where \( FDI \) is the level of foreign direct investment and is the core explanatory variable of this study.

Drawing lessons from Hulten et al. [40], in this study it is assumed that \( A(\cdot) \) and its components in Equation (2) are multiple combinations, that is:

\[ A(FDI_{it}, open_{it}, HC_{it}, t) = A_{i,0}e^{\lambda_{i}t}FDI_{it}^{\alpha_{i}} open_{it}^{\beta_{i}} HC_{it}^{\gamma_{i}} \]  

(3)

Then substituting Equation (3) into Equation (2), we can obtain Equation (4) as follows:

\[ Y_{it} = A_{i,0}e^{\lambda_{i}t}FDI_{it}^{\alpha_{i}} open_{it}^{\beta_{i}} HC_{it}^{\gamma_{i}} F(K_{it}, L_{it}) \]  

(4)

Among them, \( i \) is the region, \( t \) is the year, \( A_{i,0} \) is the initial production efficiency level, \( \lambda_{i} \) is the exogenous productivity change, \( \alpha_{i} \) is the influence parameter of FDI, \( \beta_{i} \) is the influence parameter of openness to the outside world, \( \gamma_{i} \) is the influence parameter of human capital.

According to the definition of green total factor productivity, this paper divides both sides of Equation (4) by \( F(K_{it}, L_{it}) \) to obtain the following Equation (5):

\[ GTFP_{it} = A_{i,0}e^{\lambda_{i}t}FDI_{it}^{\alpha_{i}} open_{it}^{\beta_{i}} HC_{it}^{\gamma_{i}}. \]  

(5)

where \( GTFP_{it} \) is green total factor productivity. Take the natural logarithm of Equation (5) to get the basic theoretical model.

\[ \ln GTFP_{it} = \ln A_{i,0} + \lambda_{i}t + \alpha_{i}\ln FDI_{it} + \beta_{i}\ln open_{it} + \gamma_{i}\ln HC_{it}. \]  

(6)

Therefore, combined with the research theme of this article, we take Equation (7) as the basic measurement model for studying the impact of FDI on GTFP.

\[ GTFP_{it} = \alpha_{0} + \alpha_{1} FDI_{it} + \gamma X_{it} + \epsilon_{it} \]  

(7)

In addition, the focus of this article is to examine the impact of FDI and the system on China’s GTFP, and the moderating role of the system in the path of FDI’s influence on GTFP. Therefore, we build the measurement model of this article on the basis of the above theoretical model (7) as follows:

\[ GTFP_{it} = \alpha_{0} + \alpha_{1} FDI_{it} + \alpha_{2} Z_{it} + \gamma X_{it} + \epsilon_{it} \]  

(8)
where $Z_{it}$ represents the system and is another core explanatory variable, $X_{it}$ is a series of control variables, $FDI_{it} \times Z_{it}$ represents the interaction between FDI and system. $\alpha_0$ is a constant term, $\alpha_1$ is the influence parameter of FDI, $\alpha_2$ is the influence parameter of system, $\alpha_3$ is the influence parameter of the interaction, $\gamma$ is the influence parameter of the control variable, $\epsilon_{it}$ represents the random error term, the total influence term of the explanatory variable not included in the model and some other random factors on the explained variable.

3.2. Variable Description

3.2.1. Explained Variables

Green total factor productivity (GTFP). For the measurement of GTFP, the data envelopment analysis method is widely used in academia. It is a non-parametric method, and it can calculate the GTFP of each decision unit based on the panel data without setting the production function form. Many scholars have used this method to construct different functional models to calculate TFP and have gradually improved them. Chung et al. proposed the directional distance function model, which can simultaneously realize the increase of expected output and the decrease of unexpected output, and they also constructed the output-oriented Malmquist total factor productivity index [41]. Since then, Fare, Kumar and others have constructed a Malmquist–Luenberger index considering both input and output [42,43]. However, the model assumes that the increase of expected output and the decrease of unexpected output are strictly proportional, which leads to the problem of “relaxation error”. The non-radial and non-angle SBM model constructed by Tone effectively solves the problem and is more in line with the actual production [44]. Based on the above research, this paper will use non-radial and non-angle SBM directional distance function and Malmquist–Luenberger index to calculate the GTFP index of each province in China, which can be specifically expressed as follows:

$$GTFP_{it} = \alpha_0 + \alpha_1F_{DI_{it}} + \alpha_2Z_{it} + \alpha_3(FDI_{it} \times Z_{it}) + \gamma X_{it} + \epsilon_{it}$$  \hspace{1cm} (9)

The index selection of factor input in the directional distance function mainly includes capital input, labor input and energy input. Capital input is expressed by capital stock. This paper adopts the perpetual inventory method to calculate relevant data through the formula $K_t = K_{t-1} (1-\delta) + I_t$, where $K_t$ and $I_t$ respectively represent the capital stock and fixed asset investment in the $t$ year, $\delta$ represents the depreciation rate of fixed assets, which is uniformly 10.96%. Labor input, expressed by the number of employees in each province at the end of the year. Energy input selects the total energy consumption of each province to measure. Expected output, expressed by the actual GDP of each province with the constant price based on 2007. Unexpected output includes wastewater, sulfur dioxide and industrial solid waste. The indicators are industrial wastewater emissions, industrial sulfur dioxide emissions and industrial solid waste production in each province, respectively.

This paper uses MaxDEA to calculate the growth rate of GTFP of each province from 2007 to 2016. Moreover, this article calculates the dynamic change of GTFP by referring to the multiplication thought of Hu [45]. Then, this paper further decomposes it into the green technological efficiency index (GTE) and the green technological progress index (GTP) [46,47]. GTE reflects the ratio of the distance between the actual output and the optimal output of each decision unit in the same period; GTP is the ratio of optimal outputs of decision units in different periods under the same input. Table 1 lists the average annual growth rate of GTFP and its decomposition. The overall green total factor productivity of each province is on a downward trend, and the trend of GTP is the same as that of GTFP. Therefore, the growth of GTFP is mainly attributed to GTP. In addition, we can
see that the regions where GTFP is increasing are all located in the east, namely, Beijing, Liaoning, Shanghai, Jiangsu, Zhejiang and Guangdong. The average annual growth rate of the central and western provinces is relatively close, and there is a big gap with the eastern region. The reasons may be as follows: The eastern region has a developed economy and a superior geographical location, which is sufficient to attract a large amount of capital and talents, realize local technological progress and promote the improvement of GTFP. Secondly, compared with the central and western regions, the eastern areas have a more reasonable industrial structure and stricter environmental regulations. In recent years, a large number of polluting industries have been eliminated and relocated to the central and western provinces. Therefore, the economy of the east can develop with high quality, and its development model is worth following by other regions.

| Province | Beijing | Tianjin | Hebei | Shanxi | Inner Mongolia | Liaoning |
|----------|---------|---------|-------|--------|----------------|----------|
| GTFP     | 1.10    | 0.62    | 0.95  | 0.90   | 0.88           | 1.02     |
| GTE      | 1.00    | 0.74    | 0.89  | 0.89   | 0.89           | 0.95     |
| GTP      | 1.10    | 0.83    | 1.06  | 1.01   | 0.99           | 1.07     |
| Province | Jilin   | Heilongjiang | Shanghai | Jiangsu | Zhejiang | Anhui |
| GTFP     | 0.91    | 0.86    | 1.02  | 1.67   | 1.11           | 0.89     |
| GTE      | 0.93    | 0.82    | 1.00  | 1.39   | 1.00           | 0.86     |
| GTP      | 0.99    | 1.04    | 1.02  | 1.20   | 1.11           | 1.03     |
| Province | Fujian  | Jiangxi | Shandong | Henan | Hubei | Guangdong |
| GTFP     | 0.86    | 0.86    | 0.93  | 0.94   | 0.96           | 1.01     |
| GTE      | 0.81    | 0.86    | 0.49  | 0.89   | 0.87           | 1.00     |
| GTP      | 1.06    | 1.01    | 1.91  | 1.06   | 1.10           | 1.01     |
| Province | Hunan   | Guangxi | Hainan | Sichuan | Yunnan | Guizhou |
| GTFP     | 0.96    | 0.87    | 0.67  | 0.97   | 0.88           | 0.89     |
| GTE      | 0.87    | 0.87    | 1.00  | 0.88   | 0.90           | 0.96     |
| GTP      | 1.10    | 1.01    | 0.67  | 1.10   | 0.98           | 0.93     |
| Province | Chongqing | Qinghai | Shaanxi | Xinjiang | Gansu | Ningxia |
| GTFP     | 0.90    | 0.82    | 0.91  | 0.82   | 0.84           | 0.59     |
| GTE      | 0.92    | 1.00    | 0.90  | 0.87   | 0.92           | 0.92     |
| GTP      | 0.98    | 0.82    | 1.00  | 0.94   | 0.91           | 0.65     |
| Province | Nationwide | Eastern Region | Central and Western Region |
| GTFP     | 0.92    | 1.00    | 0.88 |
| EC       | 0.91    | 0.93    | 0.90 |
| TC       | 1.02    | 1.09    | 0.98 |

3.2.2. Core Explanatory Variable

Foreign direct investment (FDI). FDI includes the flow of a package of resources such as capital, production technology and management experience among trading countries, which can promote and improve the technological level, export competitiveness, profitability and innovation capabilities of enterprises in the host country. Therefore, a single quantitative index cannot accurately measure the level of FDI. Referring to the research of Bai and Lv [48], this article constructs an index system covering the quantitative and qualitative characteristics of FDI to measure its level in a country. It mainly includes six single indexes, as shown in Table 2.

Using the data in Table 2, the level of FDI of each province in China from 2007 to 2016 can be calculated. Figure 2 shows the comprehensive level of annual average FDI by region from 2007 to 2016. First, the overall level of foreign investment in China shows an increasing trend year by year, with the most obvious increase in the east, and more fluctuation in the middle and west. Secondly, the comprehensive level of FDI varies greatly among regions. The specific manifestation is that the eastern, central and western areas gradually decrease, and the FDI level in the east is significantly higher than that in the middle and west. The above phenomenon indicates that different regions in China still have a lot of room for improvement in the introduction of high-quality FDI.
Using the data in Table 2, the level of FDI of each province in China from 2007 to 2016 gradually decrease, and the FDI level in the east is significantly higher than that in the middle and west. The above phenomenon indicates that different regions in China still have a lot of room for improvement in the introduction of high-quality FDI.

Figure 2. Annual average comprehensive level of FDI by region (2007–2016).

3.2.3. Regulatory Variable

System (Z). As mentioned above, the system is a concept involves various aspects of government, the market economy and law. Thus, we named it “government-market-law system”, hereafter referred to as “system”. This paper references the marketization index of China’s provinces continuously calculated by Fan and Wang [49], which is widely used in academia. The index is highly comprehensive, with a total of 23 detailed indicators. It includes five aspects: the relationship between government and market, the development level of denationalization, the development level of product market, the development level of factor market, the development level of market intermediary organizations and the legal systematic environment.

3.2.4. Control Variable

Based on the literature review and combined with the research themes of this paper, we introduce other control variables that may affect GTFP, including industrial structure [50,51], energy structure [52], human capital [53,54], financial development level [55–57] and urbanization level [58,59]. (1) Industrial structure (is): expressed by the ratio of the output value of the tertiary industry to the GDP. (2) Energy structure (es): Generally speaking, coal is mainly used for power generation, so the total power generation of each province is converted into standard coal consumption, then we chose the proportion of coal consumption to total energy consumption to express energy structure. (3) Human capital (hc): expressed by the average years of education of the employees in the region. (4) Financial development level (fd): expressed by the ratio of the balance of deposits and loans of financial institutions to GDP. (5) Urbanization level (urb): expressed by the proportion of urban population in the total population at the end of the year.
3.3. Data Processing

This article selects relevant data of 30 provinces, except Tibet Autonomous Region, from 2007 to 2016. The original data of each variable come from Wind Database, China Regional Economic Database, the China Fixed Asset Investment Database, China Environmental Statistical Yearbook, China Energy Statistical Yearbook, and Provincial Statistical Yearbook over the years. A small part of missing data is fitted by linear interpolation method. Before the empirical analysis, in order to eliminate the possible impact of price and heteroscedasticity on the data regression, the price-related variables were deflated based on the year 2007, and the related data were processed logarithmically.

4. Results and Discussion

4.1. Panel Data Unit Root Test

Non-stationary panel data can lead to false regression, so the unit root test should be performed before regression. The panel data in this paper are balanced, which can be tested by LLC Test, and its original hypothesis is the existence of unit root. The test results show that the five variables—‘GTFP’, ‘is’, ‘es’, ‘hc’ and ‘fd’—are all significant at the 1% level, and FDI is significant at the 5% level. System index ‘Z’ and urbanization level ‘urb’ fail the significance test, but their first-order difference LLC test results show that the null hypothesis is rejected at the 1% significance level, that is, there is no unit root. Table 3 shows the specific results, which indicates that the null hypothesis is rejected after the first-order difference of all variables, meaning the panel data to be regressed is stable.

| Variable | LLC Test | Variable | LLC Test |
|----------|----------|----------|----------|
| GTFP     | −0.9505 *** | es       | −1.2670 *** |
| FDI      | −1.1347 *** | hc       | −1.3253 *** |
| Z        | −1.4905 *** | fd       | −1.4398 *** |
| is       | −0.8672 *** | urb      | −1.0506 *** |

Note: *** indicate significance at the significance level of 1%, respectively.

4.2. Multiple Collinearity Test

Due to the improper model setting caused by the limitation of economic data, there may be a linear relationship between explanatory variables of the model. If the multicollinearity problem exists, the estimation results will be biased. Therefore, it is necessary to test whether there is multicollinearity between variables. Table 4 shows the specific test results. The variance inflation factor (VIF) of ‘urb’ is the largest, but still less than 10. Additionally, the VIF values of other variables are all less than 10, indicating no multicollinearity among variables.

| Variable | VIF | 1/VIF |
|----------|-----|-------|
| urb      | 7.13| 0.140166 |
| is       | 5.99| 0.166829 |
| fd       | 4.89| 0.204685 |
| hc       | 4.08| 0.244920 |
| FDI      | 2.29| 0.436456 |
| Z        | 2.23| 0.448336 |
| es       | 1.35| 0.742837 |
| Mean VIF | 3.99|       |

This section uses the econometric model set up above to verify the mechanism analysis part of this study. The mixed regression model, fixed-effect model and random effect model are each used for the regression of panel data, and the Hausman test shows that the empirical testing should use a fixed-effect model.
4.3. Analysis of Full Sample Regression Results

Model (7) tests the impact of FDI on GTFP. Model (8) adds system variable ‘Z’ based on Model (7). Then \( FDI_t \times Z_{it} \), the interaction term between FDI and system, is added on the basis of Model (8) to obtain Model (9), to study the regulatory effect of system. Table 5 shows the full sample regression results.

Table 5. Full sample regression results.

| Explanatory Variables | The Explained Variable GTFP |
|-----------------------|-----------------------------|
|                       | (7)                         | (8)                         | (9)                         |
| FDI                   | -0.3727 **                  | -0.3765 **                  | 0.7545 **                  |
| Z                     | 0.0101                      | 0.0702 ***                  | 0.0702 ***                 |
| FDI × Z               |                            | -0.1679 ***                 | -0.1679 ***                |
| is                    | -0.0058 *                   | -0.0067 *                   | -0.0087 **                 |
| es                    | -0.3755 *                   | -0.3769 *                   | -0.3599 *                  |
| hc                    | 0.0106                      | 0.0123                      | 0.0193                     |
| fd                    | 0.0177                      | 0.0282                      | 0.0408                     |
| urb                   | -1.2460 ***                 | -1.2735 ***                 | -1.3573 ***                |
| _cons                 | 1.9519 ***                  | 1.9088 ***                  | 1.5770 ***                 |

Note: ***, ** and * indicate significance at the significance level of 1%, 5% and 10%, respectively.

From the empirical results of Model (7), the regression coefficient of FDI is \( -0.3727 \) and passes the significance test. This means that FDI inhibits the improvement of GTFP, which verifies the “Pollution Heaven” hypothesis. This may be due to the following reasons: First, although the industries invested by the imported FDI in China have optimized, as the scale of FDI’s introduction has increased year by year, the resources consumed by productive activities and pollutant emissions are also bound to increase, which restrains the improvement of GTFP. Second, the management experience and technology spillover effect of foreign-funded enterprises do not match the localization demand. Specifically, China’s ability to learn and absorb advanced technology and management experience possessed by foreign-funded enterprises is insufficient, which makes it difficult for FDI to have a positive effect on GTFP. Third, the competition between foreign capital and local enterprises is increasingly fierce. In order to achieve monopoly, foreign-capital enterprises are unwilling to transfer their core technologies to host enterprises, which is harmful to the improvement of GTFP in host countries. According to Model (8), after the introduction of ‘Z’, the FDI coefficient is \( -0.3765 \), which indicates that FDI still inhibits GTFP. The system coefficient is 0.0101, but fails the significance test. This shows that system has a positive effect on GTFP, but not significant. It may be that the institutional change is in progress and the institutional environment is gradually improving in China. In this environment, the efficiency of factor allocation has improved, the risk of independent R&D of new technologies by enterprises has been reduced, and the enthusiasm for updating technologies has been highlighted. However, compared with other developed countries, China’s institutional environment is not good enough, which still needs to be further improved. Generally speaking, it has played a positive role but not to an obvious enough degree. Model (9) introduces the interaction term between FDI and the system. At this time, FDI promotes the improvement of GTFP with a coefficient of 0.7545 which has passed the significance test at the 5% level. This may be due to the improvement of China’s system and the expansion of the scale of introduced foreign capital. Meanwhile, many top foreign-funded enterprises are attracted to invest in the service trade and high-tech industry. The sound legal system in a favorable institutional environment increases the tendency of technology spillover of foreign-funded enterprises. The reserve of high-quality talent also improves the possibility for China to learn advanced technology and management experience of foreign-funded enterprises, thus showing a positive promotion effect on GTFP. The coefficient of the interaction term between FDI and the system is \( -0.1679 \), significant at the 1% level. Therefore, the influence of FDI on GTFP can be expressed as “\( 0.7545 - 0.1679Z \)”.
that is to say, the promoting effect of FDI on GTFP will weaken with the improvement of the system. The weakening of its promotion effect may occur because when the institutional environment reaches a certain level, China’s technological progress no longer relies too much on foreign-funded enterprises’ introduction or spillover effects, but mainly through the R&D of domestic enterprises. The epidemic will cause a “big reshuffle” of the global layout of multinational companies. Foreign investment will no longer consider the cost and market factors of the target country, but will give more consideration to the efficiency of government management and the capacity of social emergency. China has made great effort to the superiority of the system in controlling the epidemic, so that the epidemic can be controlled timely and effectively. At present, the domestic economy and trade environment has been alleviated compared with the international environment. Therefore, it is a rare opportunity for China to introduce foreign investment.

From the perspective of other control variables, the industrial structure coefficient is negative and has passed the significance test, which means the industrial structure can inhibit GTFP. Although the proportion of the tertiary industry in GDP has been increasing year by year, the manufacturing industry is still the main force of China’s economic development. Therefore, there are still problem aspects in the industrial structure, which has room for upgrading and optimization. The coefficient of energy structure is also significantly negative, indicating that China is still dominated by coal in energy consumption, seriously hindering the improvement of GTFP [60]. The human capital coefficient is positive but not statistically significant, meaning that human capital may increase GTFP. This may be because China pays more and more attention to investment in education, and the average number of years in education of employees has increased, compared with previous years. However, the proportion of high-level talents is relatively low, and the capability of independent R&D is not good enough to effectively absorb the green technologies spilled by foreign-funded enterprises. Therefore, the promotion of GTFP is not apparent. The level of financial development promotes the improvement of GTFP, indicating that China’s financial system has improved the efficiency of the financial resources allocation. Financial institutions can transfer private savings to the most efficient economic activities, such as providing financial support for the development of high-tech enterprises, increasing investment in science and technology, and upgrading technology, to move towards a higher industrial chain. Then, the urbanization coefficient is negative and has passed the significance test. This shows that the level of urbanization significantly inhibits GTFP. Perhaps because urbanization in China develops rapidly, diseconomies of scale have gradually emerged. The speed and quality of urbanization are different from each other, leading to excessive pressure on the urban environment, thus hindering the improvement of GTFP.

4.4. Analysis of Regional Regression Results

Models (11), (12) and (13), based on Model (9), represent fixed-effect models in the east, middle and west, respectively. These three models include FDI, system and the interaction terms of the two, in order to study the regulatory role of the system in the influence mechanism of FDI on GTFP. Table 6 shows the regression results. The empirical results of the eastern region are as follows: The coefficient of FDI in Model (11) is 3.7937, significant at the 1% level, showing that FDI here has apparently promoted the improvement of GTFP, and every 1% increase in FDI will drive the growth rate of GTFP by 3.7937%. It may be because the east has considered the scale of foreign investment when introducing foreign capital, as well as the projects and industries invested by foreign capital. Moreover, the east also strictly controlled the introduction of low-skilled foreign enterprises, so that it would not make it a “pollution refuge”. In recent years, the introduction of foreign capital in the eastern region has maintained a steady growth. The number of newly established large enterprises or companies that increased capital has increased, and most of them are concentrated in strategic emerging industries, reflecting the transfer of foreign capital to the high-end links of the industrial chain. For example, Shanghai, Jiangsu,
Guangdong and other places are planning to launch more major foreign-invested projects so that characteristic industries, headquarters economy and R&D centers can become important driving points. The system coefficient is 0.2550, meaning that the system also promotes the improvement of GTFP. The coefficient of the interaction term is $-0.4652$, indicating that the regulating effect of system is consistent with the performance of full samples. It may be because the large inflow of FDI in the early stage has caused the continuous accumulation of capital and the saturation of foreign investment fields. Even if the institutional environment is further improved, the elasticity coefficient of FDI on GTFP will decrease instead of increasing. The coefficients of the ‘is’ and ‘es’ variables are negative, which shows that the industrial structure and energy structure still hinder the promotion of GTFP. However, the coefficients of ‘hc’, ‘fd’ and ‘urb’ variables are positive. This indicates that the human capital, the level of financial development and the degree of urbanization all promote the growth of GTFP. Additionally, the promoting effect of the level of urbanization on GTFP may be because that the eastern regions pay more and more attention to environmental governance and protection in urbanization construction.

### Table 6. Regional regression results.

| Explanatory Variables | The Explained Variable GTFP |
|-----------------------|-----------------------------|
|                       | (11) | (12) | (13) |
| FDI                   | 3.7937 *** | −0.2662 | −0.7467 |
| Z                     | 0.2550 *** | −0.0480 *** | −0.0424 ** |
| FDI × Z               | −0.4652 *** | 0.0783 | 0.1952 ** |
| is                    | −0.0235 ** | −0.0051 ** | −0.0064 ** |
| es                    | −0.7090 | −0.0931 | −0.3689 *** |
| hc                    | 0.0160 | −0.0032 | −0.0156 |
| fd                    | 0.1827 * | −0.3035 *** | −0.2049 *** |
| urb                   | 1.6957 | −0.6574 ** | −1.3415 *** |
| _cons                 | −1.3210 | 2.1383 *** | 2.4948 *** |

Note: ***, ** and * indicate significance at the significance level of 1%, 5% and 10%, respectively.

The empirical results of the central and western regions show that the coefficients of FDI in Models (12) and (13) are respectively $-0.2662$ and $-0.7467$, which are not significant, indicating that FDI does not directly have a notable impact on GTFP in these regions. Early, foreign investment policies tended to the east. The central and western regions lacked platforms for attracting and utilizing foreign investment. The numbers of economic and technological development zones and high-tech industrial parks were far less than in some eastern provinces. Moreover, the mode of utilizing foreign capital was also relatively traditional, so the central and western regions have faced with the problem of low-end industry not being wanted and high-end industry being difficult to introduce for a long time. As a result, predictions about the quantity and quality of imported foreign capital were not optimistic, which restrains the increase of GTFP. Regarding the insignificant inhibitory effect in the middle and west, it may be because the development trend of gradient complementarity and integration with the east has gradually formed with the continuous improvement of infrastructure. What is different is that the coefficient of the FDI × Z variable is 0.1952 and has passed the significance test in the west. This means the system plays a positive regulatory role in the mechanism of FDI on GTFP, indirectly promoting the improvement of GTFP in the western areas. In other words, the negative impact of FDI on GTFP will gradually weaken with the increase of system level. When the system level improves to a certain extent, FDI will have a positive impact on GTFP. Furthermore, the control variables in the central and western regions have similar results: ‘is’ has a significantly negative effect on the growth of GTFP, so does ‘es’. And the coefficient of ‘es’ is not significant in the central region, but significant in the western, mainly because there are abundant coal resources in the west, and energy consumption is primarily coal-fired. The coefficients of the ‘hc’ variable in the two regions are negative.
This may be because human capital tends to concentrate in the eastern areas with rich resources, resulting in the continuous outflow of human capital in the middle and west. It also indicates that the investment in education in the two regions needs promoting. The coefficient of the ‘fd’ variable is negative, which shows that the level of financial development has hindered the growth of GTFP, maybe because the local financial scale is not large enough, and its efficiency needs improving. Finally, the coefficients of the ‘urb’ variable is negative and has passed the significance test, indicating that the level of urbanization has shown a significant inhibitory effect on GTFP, and urbanization needs further promotion in central and western regions.

4.5. Empirical Results of the Effective Path of FDI and System on GTFP in Different Regions

To further study regional heterogeneity, this paper will study the impact of FDI, system, and their interaction item on decomposition items of GTFP, namely, green technological efficiency (GTE) and green technological progress (GTP) in different regions. Models (14), (15) and (16) are based on Model (9), and their research objects, respectively, are the east, the middle and the west. The explained variables of the three models are all GTE. Therefore, the purpose of these three models is to study the influence of FDI and system on GTE in different regions. Similarly, Models (17), (18) and (19) are also based on Model (9), and their research objects are also the different regions. However, the explained variables of these three models are all GTP, and the aim is to study the influence of FDI and system on GTP in different regions. Tables 7 and 8 show the regression results.

Table 7. Measurement regression results of FDI and institutional influences on GTE in different regions.

| Explanatory Variables | The Explained Variable GTE |
|-----------------------|----------------------------|
|                       | (14) | (15) | (16) |
| FDI                   | 2.0867 *** | −0.2635 | −0.8978 * |
| Z                     | 0.1236 *** | −0.0177 | −0.0533 *** |
| FDI × Z               | −0.2283 *** | 0.0011 | 0.2543 *** |
| is                    | −0.0090 | −0.0050 ** | −0.0072 *** |
| es                    | −0.0579 | −0.0845 | −0.3308 *** |
| hc                    | 0.0246 | −0.0123 | −0.0175 |
| fd                    | 0.0292 | −0.0763 | −0.1862 *** |
| urb                   | −0.0329 | −1.6841 *** | −1.3340 *** |
| _cons                 | −0.0375 | 2.1922 *** | 2.5292 *** |

Note: ***, ** and * indicate significance at the significance level of 1%, 5% and 10%, respectively.

Table 8. Measurement regression results of FDI and institutional influences on GTP in different regions.

| Explanatory Variables | The Explained Variable GTP |
|-----------------------|-----------------------------|
|                       | (17) | (18) | (19) |
| FDI                   | 1.2312 | −0.6587 ** | −0.0728 |
| Z                     | 0.0693 | −0.0307 ** | −0.0385 * |
| FDI × Z               | −0.1523 | 0.0992 * | 0.2137 ** |
| is                    | −0.0117 | −0.0007 | −0.0018 |
| es                    | −0.3934 | −0.0508 | −0.3780 *** |
| hc                    | −0.0058 | 0.0054 | −0.0057 |
| fd                    | 0.1653 ** | −0.2548 *** | −0.1322 * |
| urb                   | 1.6509 * | 1.3362 *** | −0.5538 |
| _cons                 | −0.1123 | 0.9146 *** | 1.7153 *** |

Note: ***, ** and * indicate significance at the significance level of 1%, 5% and 10%, respectively.

According to the regression results of FDI, the FDI coefficients in Models (14) and (17), respectively, are 2.0867 and 1.2312, and only the former has passed the significance test. This means that the FDI in the east significantly promotes the improvement of GTE but has no distinct effect on GTP. FDI in the middle and west negatively affects GTE and GTP. The FDI coefficients in Models (16) and (18) respectively are −0.8978 and −0.6587,
and both have passed the significance test at different significance levels. This indicates that the FDI in the central region negatively affects GTP at the significance level of 5%, while it negatively affects GTE at the significance level of 10% in the west. This may be because of the policy preference at the beginning of reform and opening up. Therefore, the advanced technology and management experience brought by the large inflow of foreign capital in the east has driven the development of green production technology of local enterprises through imitation, demonstration, and knowledge spillover effect. Recently, the introduction of FDI in the eastern region mainly makes enterprises use green production technology more skillfully. Furthermore, the technology spillover effect is not apparent, which is better reflected in the significant improvement of the GTE. Moreover, from the time of introducing foreign investment, the middle is later than the east, followed by the west. Therefore, the lack of experience in attracting capital in the central and western regions is coupled with the urgent adoption of “pollution first, treatment later” by some regions here. These all have led to the inflow of foreign-funded enterprises with high pollution, high energy consumption, and low added value, which is not conducive to technological progress and efficiency in these regions.

In terms of the interaction between FDI and system, the coefficient of the interaction term in Model (14) is $-0.2283$, significant at the 1% level. Thus, the effect of FDI on GTE in the eastern can be expressed as $2.0867 - 0.2283Z$, meaning the regulatory role of system in FDI on GTFP is mainly realized by changing the GTE. It also shows that with the enhancement of the system level, the role of FDI to promote GTE in this region will gradually weaken. Specifically, the east has a developed economy, and foreign investment tends to be saturated with the improvement of the institutional environment. This will cause the optimization of the industrial structure to enter a bottleneck period, which limits the further improvement of GTE to a certain extent. From Models (15), (16), (18) and (19), the following conclusions can be drawn: For the central and western areas, the system plays a positive regulatory role in the influence of FDI on GTFP. The difference is that the regulatory effect in the middle is realized through the GTP, whereas this happens through both ways in the west. The result is related to the current macroeconomic control and policy inclination in China. The 13th Five-Year Plan proposed to vigorously guide and support the transfer of excellent industries and production bases of well-known enterprises at home and abroad in coastal areas to the central region, to promote the development of the economy. Therefore, the middle with an industrial foundation can better undertake the industrial transfer of the east, fully introducing and absorbing the advanced technology to achieve technological progress. However, the economic advantages, competitive advantages and human capital of the western region are relatively weak, so the introduction of foreign capital has not yet achieved technological breakthroughs but has improved the production efficiency of enterprises.

4.6. Robustness Test

In order to verify the robustness of the influence that FDI and system on GTFP, this paper uses the ratio of actual use of foreign direct investment to GDP, commonly used to measure the level of FDI, and then regresses the data. The setup of Models (20), (21) and (22) is respectively based on Models (7), (8) and (9). The research object is still 30 provinces of China, and the explained variable is still GTFP. The only difference is changing the indicator for measuring FDI to the ratio of actual use of foreign direct investment to GDP. The results are shown in Table 9. It can be seen that, although the value of the variable coefficient is slightly floating, the direction and significance level of GTFP is unchanged, indicating that the research conclusion of this paper are robust. Through Models (20), (21) and (22), we can see that the absolute value of the FDI’s coefficient has increased, showing that it is not accurate to measure FDI only by the ratio of actual use of foreign direct investment to GDP. Additionally, the regression results show that this method overestimates the effect of FDI on GTFP. The robustness results of the sub-regions are consistent with the previous
research results, which shows that the final research conclusion is reliable and robust. The regression results will not be listed here due to space limitation.

Table 9. The robust results of FDI and system on GTFP.

| Explanatory Variables | The Explained Variable GTFP |
|-----------------------|----------------------------|
|                       | (20)                       |
| FDI                   | -2.0975 *                  |
| Z                     | 0.0173                     |
| FDI × Z               | 0.2137 **                  |
| is                    | -0.0076 **                 |
| es                    | -0.4000 *                  |
| hc                    | 0.0087                     |
| fd                    | 0.0367                     |
| urb                   | -1.2588 ***                |
| _cons                 | 1.9814 ***                 |
|                       | (21)                       |
| FDI                   | -2.2035 **                 |
| Z                     | -0.0385 *                  |
| FDI × Z               | -0.0017                    |
| is                    | -0.0087 **                 |
| es                    | -0.4005 *                  |
| hc                    | 0.01204                    |
| fd                    | 0.0491                     |
| urb                   | -1.2950 ***                |
| _cons                 | 1.9380 ***                 |
|                       | (22)                       |
| FDI                   | -0.0728                    |
| Z                     | -0.3780 ***                |
| FDI × Z               | -0.0018                    |
| is                    | -0.018                     |
| es                    | -0.3780 ***                |
| hc                    | -0.0057                    |
| fd                    | -0.1322 *                  |
| urb                   | -0.5538                    |
| _cons                 | 1.7153 ***                 |

Note: ***, ** and * indicate significance at the significance level of 1%, 5% and 10%, respectively.

5. Conclusions and Policy Implications

With the background of realizing the “Green Recovery” of the economy, this paper theoretically analyzes the mechanism of FDI, system and their interaction term on GTFP. Then, the study takes 30 provinces of China from 2007 to 2016 as samples and selects the fixed-effect model for empirical analysis from the perspectives of the entire country and the east, middle and west. In this article, we draw the following two main conclusions. First, from the results of the national sample, the introduction of China’s FDI is unfavorable for the enhancement of GTFP. After considering the regulatory role of the system, the effect of FDI on GTFP changes from inhibition to promotion, and the promotion effect will weaken with the increase of the system level. Second, from the results of subregional regression, the FDI introduced in the eastern region is at a relatively high level, which significantly promotes the improvement of GTFP, and the regulatory effect of the system is consistent with the whole sample. The comprehensive level of FDI in the central and western areas is not beneficial to the development of GTFP, and the system in the west plays a positive regulatory role in it.

Based on the above theoretical analysis and empirical test, this paper draws the following policy implications.

First, differentiated investment introduction strategies should be formulated to deal with the relationship between FDI and GTFP under local conditions. For the east, where the overall level of FDI is relatively high, it continues to use its geographical, economic and institutional advantages to attract foreign investment. Since the epidemic, China has been the fastest to restore normal order in all walks of life. The Chinese market has become a “haven” for overseas enterprises, and the willingness of global investment to flood into China has become increasingly high. Thus, it is necessary to optimize the layout of foreign investment to promote high-quality economic development in the eastern region. Obviously, green consumption and green investment will be the development trend in the future. Therefore, for the middle and west, where the overall level of FDI is low, they should vigorously develop local characteristic advantageous industries to attract foreign investment. Meanwhile, local resource endowments should be used to guide FDI into the new energy industry and trade service industries.

Second, the expansion the reform of economic system and creating a favorable institutional environment should continue. The eastern developed provinces should continue to leverage institutional advantages, deepen the allocation of production factors, improve the market and political and legal systems. The institutional level in the central and western regions is lower and the impact of the epidemic has been more severe, so it is more difficult to resume work and production. For this reason, the government should increase support and implementation of funds and policies for the region. At the same time, it should
improve the efficiency of resource allocation to realize the positive effect of the system on the green economy as soon as possible. Moreover, the government also needs to establish a fair and transparent market competition system in all regions, increasing the enforcement of patent protection. Moreover, the punishment for patent infringement of core technology products should be increased in order to reduce the risk of independent R&D by enterprises and promote China’s technology long-term development.

Third, the interaction effect between FDI and the system should be considered objectively. For the eastern part, where the institutional environment is continuously optimized, it should focus on optimizing and creating a foreign investment environment that is international, convenient and efficient. In this way, the expectation and confidence of foreign-funded enterprises in China could be stabilized and they could contribute to the high-quality development of China’s economy. For example, in international cities like Shanghai, due to the epidemic, the difficulty in financing has become the main reason for the weakening of small and medium-sized foreign-funded enterprises (SMEs). To ease financing pressure and maintain the momentum of the long-term recovery of SMEs, Shanghai has launched a comprehensive credit service platform for SMEs in a timely manner. In addition, the central and western regions should emphasize the combination of foreign investment systems and economic transformation. For some cities with a high degree of trade openness here, a sound institutional environment should be created to guide FDI flow to high-end technology and service trade. Meanwhile, connections with foreign-funded companies should be strengthened, and full play should be given to the positive regulatory role of system in the impact mechanism of FDI on GTFP. Simultaneously, it is advisable to enhance interactive coordination and openness among regions to promote all-around openness.

The main limitation of this article is that the available data are limited. In the future, we will continue to pay attention to this issue and make more in-depth analyses.

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