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Does Foreign Direct Investment Improve Inclusive Green Growth? Empirical Evidence from China

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Abstract: Inclusive green growth is a sustainable development mode in pursuit of economic growth, social equity, and environmental protection. At present, a large number of articles have discussed the impact of foreign direct investment (FDI) on economic growth, green growth, and inclusive growth. However, the research about inclusive green growth is mainly descriptive. This paper constructs China's inclusive green growth index and analyzes the impact of FDI on inclusive green growth in China. Specifically, by constructing a super efficiency slacks-based measure model (which has two undesirable outputs: income disparity and environmental pollution) to calculate the Inclusive green growth index, this paper compares and analyses the differences and regional characteristics of China's total factor productivity, inclusive total factor productivity, green total factor productivity, and inclusive green total factor productivity. We find that total factor productivity is decreasing after considering undesirable output, and the traditional total factor productivity is higher than the inclusive green total factor productivity by 0.112; at the regional level, the trend of the total factor productivity is gradually decreasing from east to west, which indicates that there are regional differences in inclusive green growth of China, and there is room for improvement. Meanwhile, we construct a panel vector autoregressive model (PVAR) and use generalized impulse response function and variance decomposition to analyse the influence of FDI on China's inclusive green total factor productivity. The results show that FDI is beneficial to the promotion of inclusive green total factor productivity in China, and environmental pollution in the FDI process is an important factor hindering the inclusive green total factor productivity.

Keywords: FDI; environmental pollution; inclusive green growth; total factor productivity; income disparity

JEL Classification: O24; O47

1. Introduction

Since the Asian Development Bank proposed "inclusive growth" in 2007, the term "inclusiveness" has become a high frequency word in many international political conferences and academic seminars. Many countries have taken it as their national development goals to solve the problems of unbalanced development. At the same time, the "green growth", another growth mode related to inclusive growth, has attracted a lot of attention from scholars. Inclusive growth focuses on income distribution, while green growth focuses on the greens of growth. Most scholars regard them as autonomous subjects. The term "inclusive green growth" was first put forward by the Rio G20 summit in 2012. Obviously, inclusive green growth must take into account both "inclusiveness" and the concept of "green".

Foreign direct investment (FDI) can promote the economic growth of the host country by enhancing its total factor productivity (TFP) of the host country. The theory has been widely argued

(Ng et al. 2005; Salim and Bloch 2009; Kim et al. 2015). Unlike the past, most developing countries are facing the contradiction between economic growth and environmental pollution, and the widening income gap. Unlike in the past, these developing countries are more concerned than ever about how to address this contradiction. For example, India's "poverty alleviation growth" and the "inclusive growth" of some countries are promoting social progress by curbing environmental pollution or narrowing the income gap. However, can FDI enhance the inclusive TFP of a country and promote economic inclusive green growth? For the healthy and sustainable development of the society, how do the developing countries introduce FDI strategically? This is an issue now worthy of concern.

Currently, scholars mainly discuss the impact of FDI on economic inclusiveness (Tan et al. 2016) or the impact of FDI on economic green growth (Yue et al. 2016). However, whether FDI can promote the inclusive and green growth of the economy has not yet been tested. Even though there is no institution to count the index of inclusive green growth, it is still feasible to analyze inclusive green growth in the perspective of total factor productivity, such as green growth and inclusive growth. In the construction of the total factor productivity index, the current research mainly adopts two methods. One is to use economic growth model to build the regression equation, and then decompose total factor productivity (i.e., growth accounting approach). The other is to use the data envelopment analysis (DEA) method to carry out input output analysis. The advantage of the DEA method is that TFP can be obtained without assuming specific production functions in advance. The income gap and environmental pollution are two kinds of undesired output in the process of economic growth. Therefore, we choose the super efficiency slacks-based measure model with unexpected output to solve the total factor productivity (Li et al. 2013b).

China is the largest developing country in the world. The total gross domestic product (GDP) had risen from 365 billion yuan in 1978 to 82,700 billion yuan in 2017, with an average annual growth rate of nearly 9.6%. China's Strategic Introduction of FDI played a significant role in the rapid growth of China's economy. In 2017, China attracted FDI for 877,560 million yuan, ranking first among developing countries. However China's extensive growth has also brought many problems to its society. For instance, the Gini coefficient in the past 10 years has always been higher than 0.4, and nearly 20 provinces in 31 provinces of the country often have serious haze pollution. During the 19th National Congress of Communist Party of China, President Xi said that "the principal contradiction facing Chinese society has evolved. What we now face is the contradiction between unbalanced and inadequate development and the people's ever-growing needs for a better life". The transformation of the main contradiction is rooted in the lack of inclusiveness and the shortage of "green" in the process of growth. To solve the contradiction, we need to start with two aspects: improving economic inclusiveness and green. Therefore, inclusive green growth, as the main theme of economic growth in contemporary China, can achieve more inclusive economic development.

Therefore, in this article, we take China as a case study to see whether FDI can promote inclusive green growth. We explore the impact of FDI on the inclusive green growth of China's economy and explore the impact of FDI on the inclusive green economy from the perspective of total factor productivity. On the one hand, it can enrich the theoretical research of inclusive green growth, clarify the impact mechanism of FDI on inclusive green growth, and provide a reliable experience support for the construction of inclusive green growth theory. On the other hand, it can also provide policy suggestions on how to better introduce foreign direct investment, promote the traditional total factor productivity and enhance the inclusive green level of economic growth under the new normal state. The rest of the article is structured as follows. Section 2 introduces FDI's research on inclusive green growth. Section 3 introduces the construction method of inclusive green total factor productivity. It also introduces the panel vector autoregressive (PVAR), the generalized impulse response function, and the variance decomposition technique which are utilized to depict the impact of FDI on inclusive green total factor productivity. Section 4 makes a comparative analysis of China's four TFP. Section 5 analyzes how FDI affects China's inclusive green total factor productivity. Section 6 concludes.

2. Literature Review

As a new theory of economic growth in the twenty-first Century, current research on inclusive green growth is manifested in the following two aspects. First, some articles describe the connotation and essence of inclusive growth. Fay (2012) emphasizes that economic sustainable development needs both green growth and inclusive growth, while inclusive green growth is an important way to achieve sustainable development. Spratt and Stephany (2013) believes that inclusive green growth is an inclusive approach for the efficient use of natural resources, to control the impact of pollution on the environment and ensure that the growth process is inclusive. Bouma and Berkhout (2015) point out that inclusive green growth should weigh the relationship between growth, green and inclusive three. In the process of development, we need to ensure the economic welfare of the contemporary people and not damage the welfare of future generations. Zhou et al. (2018) believe that inclusive green growth is a sustainable approach to pursue economic growth, social equity, results sharing, resource conservation and good ecological environment. Although many scholars have made different explanations for inclusive green growth from different angles, there is no doubt that economic growth is still the first priority. Reducing the income disparity is its due meaning, and environmental issues are the key to achieving inclusive green growth. Compared to "poverty reduction", "shared growth" and "green growth", inclusive green growth not only requires economic growth and improvement of the livelihood of the people, but also demands an increase in ecological efficiency. Second, some studies have already defined and measured inclusive green growth indicators. Yang (2014) constructed the G20 national inclusive green development index. On this basis, Zhou et al. (2018) proposed a comprehensive index to measure inclusive green growth in combination with a variety of economic, social and environmental indicators, and explored the impact of a series of various factors on the inclusiveness, such as education, infrastructure construction and urbanization.

At present, only a few articles focus on inclusive green development. Among them, the literature studies FDI's impact on inclusive green development is even more rare. Nevertheless, if we divide the connotation of inclusive green development, the existing literature which has discussed the impact of FDI on inclusive green development come from three aspects at least.

Firstly, to improve the total factor productivity[1] is the inherent requirement of inclusive green development, and it is also an inevitable requirement to achieve high quality of economic development. FDI can affect inclusive green development through total factor productivity. In the early days, scholars focused primarily on the relationship between FDI and TFP. Generally speaking, people tend to think that the endogenous advantages of foreign enterprises, such as product production technology, management technology, market and marketing technology, will spillover in the process of FDI and improve the total factor productivity of the host country (Ari et al. 1996; Liu et al. 2000; Li and Yu 2011). However, some scholars have different views on this. Damijan and Knell (2005) believe that whether FDI can bring technology spillovers depends on the institutional environment of the host country, and they show that the FDI of the Eastern European economies does not have technical spillovers. Wolfgang and Yeaple (2009) think that the technology spillover effect of FDI can only appear when there is a certain technical potential differences. In addition, some studies show that there are specified threshold conditions for FDI's technology spillover (Wang et al. 2012; Zhong et al. 2013). Secondly, FDI will affect the quality of the host's natural environment, and then affect inclusive green growth, that is, FDI can have a definite impact on the efficiency of green technology. Cheng et al. (2011) research on the efficiency of China's economic growth has found that due to environmental constraints, FDI has played an inhibitory role in improving China's economic efficiency. As noted by Jing and Zhang (2014), the absorption of FDI in china has a positive spillover effect and a negative product structure effect.

[1] In order to distinguish all kinds of total factor productivity, the traditional total factor productivity (TFP) is generally described as the total factor productivity (TFP), that is, the total factor productivity calculated by the same input without considering the environmental pollution and the income disparity.

Hu et al. (2017) use the spatial econometric model to study the data of China's provinces and finds that FDI has a significant impact on the convergence of green technical efficiency in various regions of China. Thirdly, FDI affects the inclusiveness of economic growth through the income gap, thus affecting inclusive green growth. But in this respect, due to the different perspectives and methods, scholars have not reached a consistent view. Ma (2012) has empirically analyzed the possible factors of inclusive growth and believes that the impact of FDI on inclusiveness is not obvious. Xu et al. (2015) divide China into several regions and explores the impact of foreign investment on China's inclusiveness under the constraints of carbon emissions. They find that among many factors, foreign investment has the greatest impact on the inclusiveness of China. Hu and Qi (2016) also make an empirical analysis and show that FDI promotes the inclusiveness of China's economic growth.

In view of this, this paper analyzes the impact of FDI on inclusive green growth from three paths: total factor productivity, green technology efficiency and inclusive growth. Therefore, the contributions of this study are mainly reflected in the following two points. One is that the inclusive green total factor productivity index of all provinces and regions of China is calculated by using the super-efficient non radial slacks-based measure model (SBM) which the income disparity and environmental pollution are innovatively as the undesired output of economic development. This paper makes a comparative analysis of inclusive green total factor productivity and all factor productivity levels, the regional differences are also been taken into account. Furthermore, we have analyzed the impact of FDI on inclusive green growth for the first time. Specifically, we construct a PVAR, and use generalized impulse response and generalized variance decomposition to analyze the impact of FDI on inclusive green total factor productivity in China. This paper preliminaries clarifies the influence mechanism of FDI on China's economic growth and provides relevant policy suggestions about how China can better implement the foreign direct investment strategy under the new normal state.

3. Method and Variable Declaration

3.1. Construction of Inclusive Green Total Factor Productivity Index

The data envelopment analysis (DEA) proposed by Charnes et al. (1985) is solved by linear programming. In the case of small sample size, if the research problem is multi input and prolific, DEA has a unique advantage and is widely used to assess the efficiency of departments. The traditional DEA is prone to multiple efficiency of 1; sometimes it is impossible to measure and compare the efficient decision-making units (DMU). Andersen and Petersen (1993) improved the model, and proposed a super-efficient DEA model to measure and sort the efficiency value of multiple efficient units. However, the super efficiency DEA model still appears to be unmeasurable when facing variable scale returns. In order to overcome the above problems, Tone (2001) constructed a SBM model based on relaxation measure and non-radial methods to estimate efficiency, and then combined the SBM model with the super-efficient DEA model to proposes a super-efficient SBM model (Tone 2002). In addition, in the process of production and life, economic society is often accompanied by undesired output, such as waste water, income disparity and so on. Tone (2004) proposed a SBM model with undesired output. Li et al. (2013b) added the undesired outputs to the super-efficient SBM model, and put forward the super-efficient SBM model with undesired output, and analyzed the environmental efficiency of China's economic development.

It is assumed that the number of decision making units (DMU) is n, Each DMU has m inputs, r_1 expected outputs, and r_2 undesirable outputs. $x \in R^m, y^d \in R^{r_1}, y^u \in R^{r_2}$. X, Y and Z represent input, expected output and undesirable output matrix respectively. $X = [x_1, \cdots, x_2]$, $Y^d = [y_1^d, \cdots, y_n^d] \in \mathbb{R}^{r_1 \times n}$, $Y^u = [y_1^u, \cdots, y_n^u] \in \mathbb{R}^{r_2 \times n}$. We assume that, $X > 0, Y^d > 0, Y^u > 0$. Then the production possibility set (p) is defined by:

$$p = \left\{ \left(x, y^d, y^u \right) \middle| x \geq X\lambda, y^d \leq Y^d\lambda, y^u \geq Y^u\lambda, \lambda \geq 0 \right\}$$

where λ is the intensity vector. The super-efficient undesired SBM fractional programming model is represented as follows:

$$\min\rho = \frac{1/m\sum_{i=1}^{m}(\overline{x}/x_{ik})}{1/(r_1+r_2)(\sum_{s=1}^{r_1}\overline{y}^d/y_{sk}^d+\sum_{q=1}^{r_2}\overline{y}^u/y_{qk}^u)}$$

$$\text{Subject to } \overline{x} \geq \sum_{i=1,\neq k}^{n} x_{ij}\lambda_j; \quad \overline{y}^d \leq \sum_{j=1,\neq k}^{n} y_{sj}^d\lambda_j; \quad \overline{y}^u \geq \sum_{j=1,\neq k}^{n} y_{qj}^u\lambda_j$$

$$\begin{array}{llllll} i=1,\cdots,m & s=1,\cdots,r_1 & q=1,\cdots,r_2 & & & \\ \lambda_j>0, & j=1,\cdots,n & j\neq 0 & x\geq x_k & \overline{y}^d\leq y_k^d & \overline{y}^u\geq y_k^u \end{array}$$

We use ρ to represent total factor productivity instead of decomposition into technological change and efficiency change, just like Jing and Zhang (2014). Because the change of technology reflects the change of the total factor productivity of the sample frontiers, which may come from the optimization of the combination of technical equipment and production process. In addition, the change of efficiency reflects the absorption level of technology in the current production, which should be included in the traditional TFP. Therefore, this paper calculates the traditional total factor productivity, green total factor productivity, inclusive total factor productivity, and inclusive green total factor productivity using the super-efficient SBM model and the super-efficient SBM model with unexpected output.

3.2. The PVAR Model of FDI Impact on Inclusive Green Total Factor Productivity

We studied the impact of FDI on inclusive green TFP. After calculating the traditional total factor productivity and inclusive green total factor productivity, we needed to choose the appropriate measurement method for analysis. Since the data vector autoregressive model (PVAR) proposed by Holtz-Eakin et al. (1988) can analyze the relationship between variables, it does not need to explore the intrinsic relationship between variables in advance and consider the endogenous, exogenous and causality of variables. So we set up the PVAR model as follows:

$$X_{it} = \alpha_i + \beta_1 X_{i,t-1} + \beta_2 X_{i,t-2} + \cdots + \beta_n X_{i,t-n} + \lambda_{it} + \varepsilon_{it}$$

X_{it} is a variable vector consisting of six variables, including traditional total factor productivity (TFP), foreign direct investment (FDI), economic growth (GDP), environmental pollution (POL), income disparity (IND), and inclusive green total factor productivity (IGTFP). α_i is the individual influence of i area, λ_{it} indicates time effect, and ε_{it} is random disturbance term vector.

3.3. Generalized Impulse Response Function (GIRFs) and Generalized Variance Decomposition Function

The PVAR theory uses the orthogonalization impulse response function to analyze the impact of a certain endogenous variable impact on other endogenous variables. The results depend on the sequencing of endogenous variables in the VAR system, and the ordering is mainly based on the exogeny of endogenous variables in sequence. However, in the process of research, according to different theories of the VAR system, exogenous strengths and weaknesses between variables are often not easy to judge. The same problem is also in the PVAR model. In this paper, the generalized impulse response function developed by Pesaran and Shin (1998) is applied to PVAR model analysis. Specifically, a unit standard deviation impact on the final response of the j variable in the i equation of the PVAR model in the N phase is as follows:

$$G_{ij,N} = \left(e_j'\psi_N\sum e_i\right)/(\sigma_{ii})^{1/2}, i,j = 1,2,\cdots,N$$

In the upper form, Σ is a N dimensional covariance matrix obeying normal distribution. $(\sigma_{ii})^{1/2}$ represents the impact of a unit standard deviation. e_t is $N\times 1$ matrix, the element i is 1,

and the rest is 0. Corresponding to generalized impulse response, this paper also uses generalized variance decomposition technique to measure the composition of the impact of each variable.

$$\Psi_{ij,N} = \left[\sigma_{ii}^{-1}\sum_{k=0}^{N}\left(e_j^{'}A_k\Sigma e_i\right)^2\right] / \left[\sum_{k=0}^{N} e_i^{'}A_k\Sigma A_k^{'}e_i\right]$$

where $k = 1, 2, \cdots, N; i = 1, 2, \cdots, m$, $A_j = \Phi_1 A_{j-1} + \Phi_2 A_{j-2} + \cdots + \Phi_p A_{j-p}, j = 1, 2, \cdots$ A_j is the parameter matrix corresponding to the PVAR (p) lagging operator, and the rest of the variables are defined with the generalized impulse response function.

3.4. Variable Declaration

Since the 21st century, the rapid development of China's economy has also been accompanied by the aggravation of environmental pollution and the widening income gap. Therefore, this paper uses the panel data of 29 provinces (municipalities directly under the central government) from 2000 to 2015 (Chongqing was established in 1996, the corresponding capital stock data could be obtained through calculation, so it was incorporated into Sichuan Province, and Tibet was not included because of incomplete data). The basic data are derived from the statistical yearbook of China, the compilation of sixty years of statistical data in New China, the annals of China's environmental statistics, the WIND database, and annual statistical yearbooks of the provinces.

FDI is expressed by the actual utilization of foreign direct investment in every province each year. Labor, capital, and energy consumption were selected as input variables of the super-efficient SBM model which with undesirable outputs. Compared with only labor and capital as input variables, this paper held that China is a big country of energy consumption, and energy efficiency is relatively low, but energy plays an important role in the process of China's economic progress. Therefore, it is necessary to take it as an essential input variable. Labor input was represented by the sum of the end employment figures in diverse industries. Capital investment is calculated by the capital stock of each province at the end of the year. In particular, the capital stock data of each province in 1998 (1952 as the base period) was obtained according to the study of Shan (2008), and then the capital stock of each province was estimated using the national fixed assets investment price index and the fixed asset investment data at a 10.96% depreciation rate. It was further transformed into a capital stock based on 2000. Energy input was expressed in the total energy consumption of each province over the year, and the unit was 10,000 tons of standard coal.

Output variables included expected output and undesirable output, taking the actual GDP based on 2000 as an expected output. Undesired outputs included income disparity and environmental pollution. China lacks the statistics of the Gini coefficient in different provinces, but the typical gap between urban and rural areas is the main source of China's income disparity (Wang et al. 2007). Therefore, the income gap was obtained by dividing the per capita disposable income of urban residents, divided by the per capita net income of rural residents. For the selection of environmental pollution indicators, factor analysis was used to transform waste water, industrial waste gas, and industrial waste into a variable as a surrogate variable of environmental pollution.[2] Table 1 shows the input-output indicators for calculating the four TFP.

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[2] The data of FDI, three major industries, urban residents and rural residents' income, energy consumption, GDP, fixed assets investment and price index can easily be found in EDB database of WIND (http://www.wind.com.cn/NewSite/edb.html) or collected from the statistical yearbook of China. Environmental pollution data originate from NBSC (2010) and Chinese data from National Bureau of Statistics website (http://www.stats.gov.cn/ztjc/ztsj/hjtjzl/).

Table 1. Input-output variables of four total factor productivities (TFPs).

Variable Category	Variable Name	Total Factor Productivity	Green Total Factor Productivity	Inclusive Total Factor Productivity	Inclusive Green Total Factor Productivity
Inputs	Labor	√	√	√	√
	Capital	√	√	√	√
	Energy	√	√	√	√
Desirable outputs	Gross domestic product (GDP)	√	√	√	√
Undesirable outputs	income disparity	□	□	√	√
	Environmental Pollution	□	√	□	√

4. The Comparative Analysis of Four Total Factor Productivities in China

The inclusive green TFP, inclusive TFP, green TFP, and traditional TFP from 2000 to 2015 were calculated by using the super-efficient SBM model with unexpected output, and the general super efficiency SBM model respectively, and the average value was calculated further. The key calculation results are summarized in Table 2. Next, we analyzed the difference between the four TFP from the overall and regional perspectives.

Table 2. China's provinces' (2000–2015) inclusive green TFP (IGTFP), inclusive TFP (ITFP), green TFP (GTFP), and traditional TFP, as estimated by slacks-based measure model (SBM).

Provinces	IGTFP	ITFP	GTFP	TFP	Provinces	IGTFP	ITFP	GTFP	TFP
Beijing	0.9676	1.012	0.9804	1.0221	Hubei	0.4969	0.5327	0.5121	0.566
Tianjin	0.8471	0.8639	0.9053	0.9248	Hunan	0.4768	0.5454	0.5308	0.5978
Hebei	0.418	0.4946	0.4873	0.5793	Guangdong	0.9622	0.9915	0.9897	1.0277
Shanxi	0.3833	0.4571	0.4499	0.5303	Guangxi	0.3982	0.4801	0.4752	0.5941
Inner Mongolia	0.4677	0.5177	0.5065	0.5718	Hainan	0.4467	0.5642	0.5783	0.7205
Liaoning	0.6835	0.7046	0.6924	0.7285	Sichuan	0.4359	0.4893	0.4874	0.5349
Jilin	0.4204	0.5126	0.4917	0.5971	Guizhou	0.2729	0.3413	0.3233	0.3986
Heilongjiang	0.4752	0.5693	0.5532	0.6384	Yunnan	0.5214	0.5536	0.5367	0.5744
Shanghai	0.9509	1.0004	0.9862	1.0323	Shaanxi	0.5049	0.5249	0.5159	0.5294
Jiangsu	0.8868	0.8824	0.9	0.8947	Gansu	0.3666	0.3909	0.3729	0.3981
Zhejiang	0.6456	0.7289	0.7046	0.8121	Qinghai	0.2961	0.3672	0.3503	0.4202
Anhui	0.4506	0.5314	0.5017	0.6015	Ningxia	0.2964	0.3464	0.3309	0.3982
Fujian	0.6592	0.7376	0.7381	0.8416	Xinjiang	0.3709	0.4452	0.4226	0.5022
Jiangxi	0.3663	0.4636	0.442	0.5486	Eastern Region	0.7297	0.7788	0.7728	0.8356
Shandong	0.5196	0.5664	0.5587	0.6279	Central region	0.4411	0.5137	0.4961	0.5781
Henan	0.4592	0.4977	0.4873	0.5451	Western Region	0.3931	0.4457	0.4322	0.4922

At a glance, we found that inclusive green TFP < green TFP < inclusive TFP < traditional TFP. In the aspects of green TFP and inclusive TFP, this article paralleled the conclusions from Chen (2010) considering environmental factors, and Chen and Qin (2014) considering the income gap, whose results all showed that the TFP of undesired output is less than the traditional TFP. This phenomenon shows that the pollution emission and the widening income gap in the process of economic growth have caused losses to China's TFP. However, we found that the inclusive green TFP was obviously less than the inclusive TFP and the green TFP when the environmental pollution and the income gap were made available for the model as undesired outputs. The reason is not hard to understand. In the same environment, although investment has contributed to economic growth, it has also brought about two negative outputs, namely, environmental pollution and income disparity. In reality, blindly pursuing the speed of economic growth and neglecting the quality of growth often leads to overestimation of economic development and TFP. This also reflects that inclusive green TFP is a better progress indicator. According to the calculation of Table 1, the average Chinese TFP index was higher than the inclusive green TFP index by 0.112, which reflects that the overall economic inclusive green level of China is weak, indicating that the main contradiction of the current social development in China is relatively sharp, and that the inclusive green TFP still has a lot of room for promotion. In addition,

the inclusive TFP index was larger than the green TFP index for the whole country or for most of the provinces, indicating that green development will still be the main theme of development for a long time in the future.

At the regional level, there was a noteworthy difference in four TFP. According to the traditional regional division standards, China is divided into three regions[3]. The four types of total factor productivity in the three major regions are gradually decreasing from east to west. This finding also resonates with the proposition of Kuang and Peng (2012) that whether green TFP or traditional TFP are considered, the western and central regions are lagging behind. This shows that the Middle East and West China have brought about a decline in the level of efficiency because of the income gap and emissions, and it seems that there may be a more serious income disparity and impacts to the environment in the middle and western regions. In fact, the average gap between 2000 and 2015 in East, middle and western regions was 2.51, 2.73 and 3.59, respectively. Energy consumption (ton standard coal) of GDP per 10,000 yuan was 0.92, 1.29 and 1.81 respectively. Therefore, in the case of the adverse effects of economic growth on income disparity and the environment, the four kinds of TFP gaps between the two regions and the eastern region are even greater. Since the reform and opening up, the eastern region has been developing rapidly with excellent location advantages and policy guidance, and the level of production technology has been greatly improved. At the same time, the intensity of environmental regulation and pollution control ability of the eastern region are higher than that in the middle and western regions. Therefore, it can be noted that the economic development of the eastern region is more inclusive and green.

It is worth noting that the inclusive green total factor productivity level in Hainan and Hebei was low in the eastern region. The main reason for this is that economic growth efficiency of Hainan is low, and the production process of Hebei is more polluted. The degree of pollution in the central and western regions is relatively low, but the economic development is relatively backward, and there is still a large income gap between urban and rural areas. This makes the inclusive green TFP index of the two regions relatively small, and the inclusive green index is 0.44 and 0.39 respectively. At present, the model of economic development after pollution treatment is not suitable for the requirements of the time. Therefore, in the process of future advance, the central and western regions need to force three aspects of promoting growth, reducing pollution, and shrinking the gap. The eastern region mainly needs to consider reducing pollution and shrinking the gap so as to promote the inclusiveness of economic development and realize the high quality development of the economy.

5. The Empirical Analysis of the Impact of FDI on Inclusive Green Total Factor Productivity in China

5.1. Panel Data Unit Root Test and Cointegration Test

Before performing PVAR analysis, we needed to test the stationarity of variables. The main methods of unit root test of panel data included Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS), PP-Fisher (PPF). After logarithmic processing of FDI, IGTFP, GDP, environmental pollution, income disparity, and traditional TFP, it was found that all the variables had unit roots, and after the first-order difference, the stability results are showed in Table 3. The results show that Dln(GDP) was tested by IPS and PPF unit root tests at a 10% significance level, and the LLC test was performed at a 1% significance level. The remaining variables were tested at the 1% significant level for the unit root test of the three methods, that is, all variables were first order single integer variables.

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[3] The eastern region: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan. The central region: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan. Western Regions: Inner Mongolia, Guangxi, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Ningxia, Qinghai, Xinjiang.

Table 3. Variables unit root test results.

Variables	Methods		
	LLC	IPS	PPF
Dln(FDI)	−14.4629 ***	−8.3044 ***	237.058 ***
Dln(IGTFP)	−5.6802 ***	−6.9640 ***	262.4440 ***
Dln(GDP)	−2.9218 ***	−1.5451 *	72.4297 *
Dln(POL)	−6.0103 ***	−4.0040 ***	97.1240 ***
Dln(IND)	−13.3920 ***	−9.5194 ***	338.4216 ***
Dln(TFP)	−3.9361 ***	−4.5288 ***	165.5121 ***

Note: "*" and "***" are significant respectively at the confidence level of 10% and 1%, ln(#) means the logarithm, and the D means the first order difference.

The panel data cointegration test is carried out. In the process of testing, the optimal lag order was determined to be 2 according to the Bayesian Information Criterion (BIC) criterion. Test results of six panel data test methods, as shown in Table 4, indicated that there was a long-term stable equilibrium relationship between the variables studied in this paper.

Table 4. The results of the cointegration test.

Methods	Panel v	Panel PP	Panel ADF	Group Rho	Group PP	Group ADF
Statistic	−2.9874	−0.3621 ***	−2.8577 ***	7.0712	−5.4549 ***	−2.8200 ***
***p* value**	1.0000	0.0000	0.0021	1.0000	0.0000	0.0024

Note: "***" is significant respectively at the confidence level of 1%.

5.2. Generalized Impulse Response Analysis of FDI on Inclusive Green Total Factor Productivity in China

In this paper, the PVAR model was estimated by the generalized moment estimation (GMM). The lag order of the variables was selected according to the convergence of the impulse response function, and the PVAR with 2 orders of delay was selected. In order to avoid the deviation between the individual effect and the time effect, the mean difference of the cross section and the Helmet forward mean difference were used to deal with the data further. Because use of the regression coefficients of the vector autoregressive model were difficult for explaining the relationship between variables, the generalized impulse response function and the generalized variance decomposition were used to explain the interaction between the FDI and the inclusive green total factor productivity in China.

Figure 1 shows the main empirical findings: FDI can promote inclusive green development in China. According to the response path of inclusive green total factor productivity to FDI shock, the response of inclusive green total factor productivity in the early stage was positive (0.0115) and reached the maximum (0.0193) in the second phase. As time went on, the impact of FDI on inclusive green total factor productivity tended to converge after the fourth period. The results showed that China's FDI can bring inclusive green total factor productivity improvement since the beginning of the 21st century, and it has a positive effect in general. Thus, under the new normal economic environment, opening wider to the outside world will be conducive to inclusive and green development of China's economy. However, the impact of FDI on the inclusive green TFP is relatively small. As inclusive green total factor productivity takes into account the income gap and environmental pollution, the further study of the impact of FDI on inclusive green total factor productivity needs not only to examine how FDI affects economic growth and total factor productivity, but also to clarify the impact of FDI on income gap and environmental pollution. Figure 1 also demonstrates that the TFP can promote inclusive green total factor productivity both in the long and short term, which indicates that China's traditional total factor productivity is inclusive. From the response path of inclusive green total factor productivity to self-impact, we can find that inclusive green total factor productivity has path dependence.

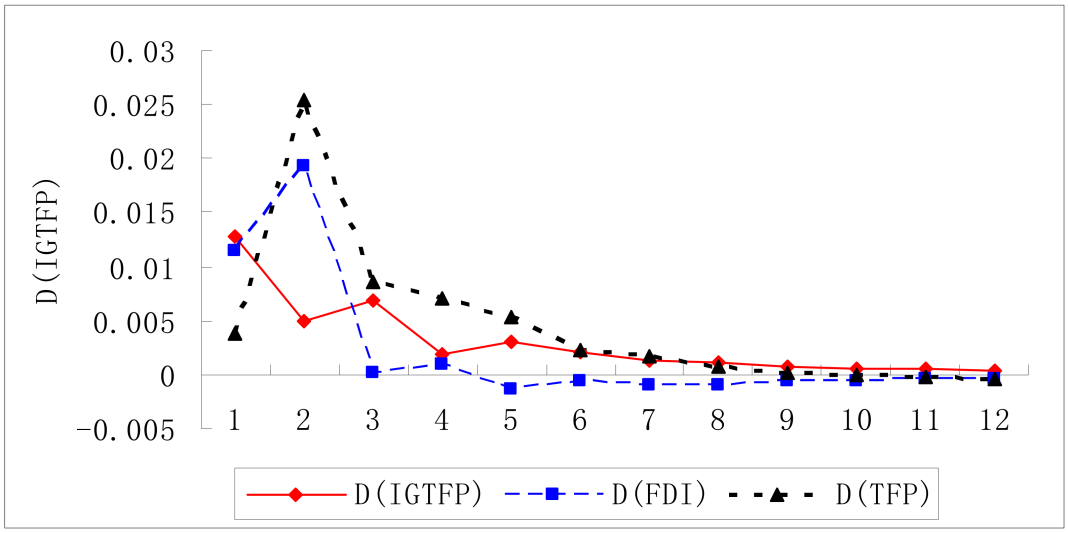

Figure 1. Inclusive green total factor productivity response to foreign direct investment (FDI), TFP, and self-shock.

The response of inclusive green TFP to economic growth, environmental pollution, and income disparity shocks are shown in Figure 2. The impact of inclusive green total factor productivity on economic growth showed a significant negative response in the first and third phases, but the maximum positive response value (0.0247) was reached in the second phase. Economic growth showed a positive response to inclusive green total factor productivity as a whole. The results suggested that although economic growth is the top priority, relying solely on this does not necessarily lead to inclusive and green development. At the same time, it also showed that the development model of quantity-adding focusing and ignoring quality-improvement is not in line with the requirements of economic inclusive green development. This means that the quality of China's economic growth still has a greater promotion space which echo the previously cited findings about the quality of China's economic growth (Chen and Qin 2014). The response of inclusive green TFP to environmental impact is negative, and the convergence process is relatively mild. It can be seen that China's environmental regulation has a poor effect on inclusive green total factor productivity at this stage. It is noteworthy that the response of inclusive green TFP to the income disparity was positive in the second period, and the remaining periods were negative. This is mainly because the expansion of the income disparity will directly affect social equity, exacerbate social contradictions, and impede inclusive green total factor productivity, but the appropriate income disparity can bring vitality to the economy and society, promote economic growth, and promote economic development to a higher quality.

However, from Figure 3, we can note that inclusive TFP, FDI and income gap will also affect traditional TFP. Inclusive green TFP can significantly promote traditional TFP. This shows that there is a positive interaction between TFP and inclusive TFP. The response of traditional TFP to FDI shock is positive in the first three periods, and then rapidly converges to zero. It shows that FDI can improve traditional TFP, but the effect is not noticeable. Traditional total factor productivity was negative in the current period and became positive in the second period before it slowly converged. This shows that China's current income gap has played an incentive role in the economy and society development and promoted traditional total factor productivity.

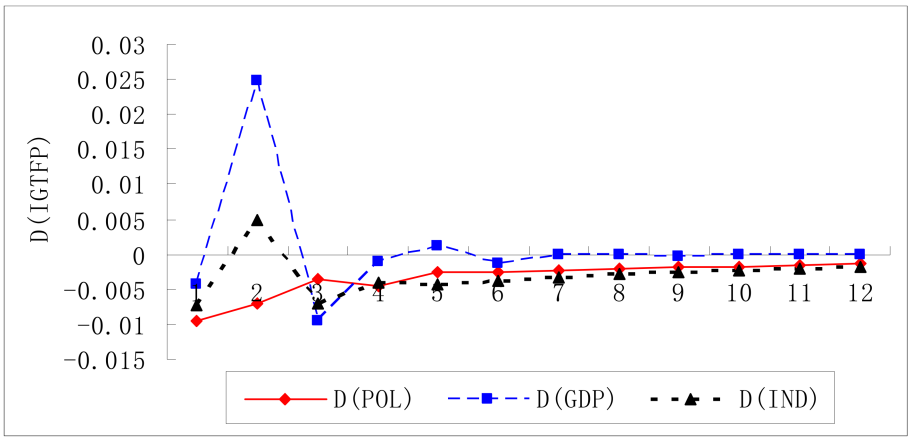

Figure 2. Inclusive green total factor productivity response to economic growth, environmental pollution and income disparity shock.

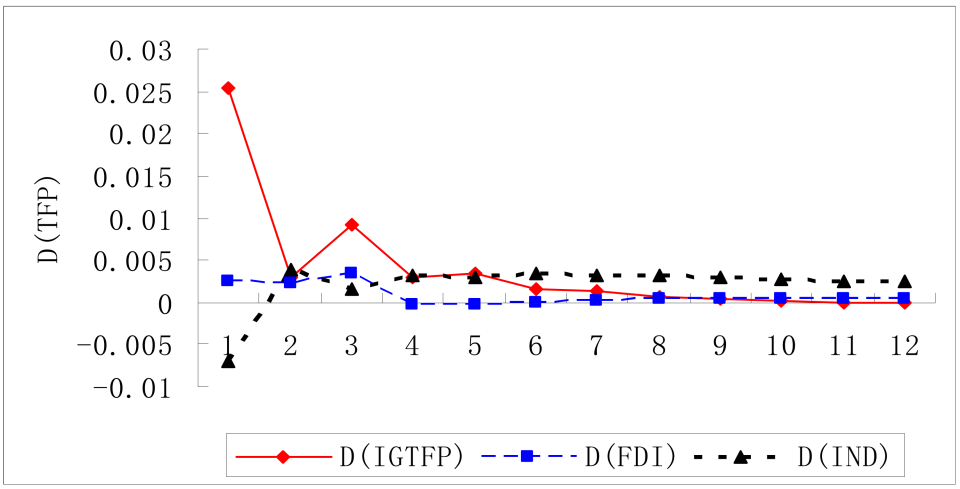

Figure 3. TFP response to IGTFP, FDI and income disparity shock.

Figure 4 shows that in the short term, FDI will cause more environmental pollution. Although the response value was negative after the third period, it was still unable to offset the positive effect of the first two periods. For a long time, GDP was the main assessment target of the government, and the high output value of FDI was welcomed by the local government, so environmental control was weak, which made the "pollution shelter" effect stronger than the "pollution halo" effect. This result was in line with the results of Jin and Wang (2016). The response of environmental pollution to the impact of traditional total factor productivity was negative, showing that Chinese traditional total factor productivity has environmental bias generally, which can reduce the emission of pollution. In the short term, economic growth will bring environmental pollution, but as time goes on, the positive effect of economic growth on environmental pollution will gradually weaken or even be inhibited. This response is consistent with the "inverted U" shape of the environmental Kuznets curve.

In Figure 5, we can see that the income disparity was positive for FDI, TFP and economic growth, and it widened the income disparity. Income gap was most affected by economic growth, followed by traditional total factor productivity, and FDI had the least impact. For developing countries, FDI will flow more into capital and technology intensive industries. On the one hand, the income gap between skilled workers and unskilled workers will be widened. On the other hand, with the increase of China's social capital returns, the inflow of FDI will have a certain amplification effect on the income disparity (Wan et al. 2005).

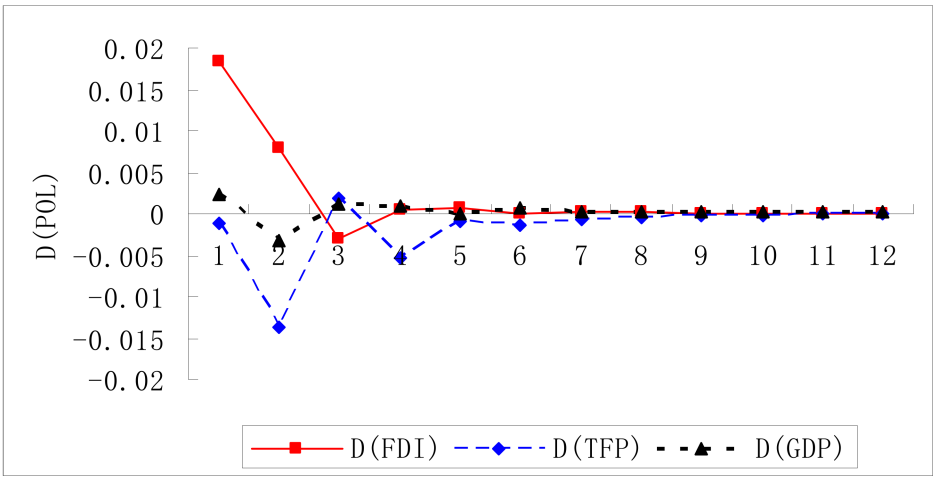

Figure 4. Environmental pollution response to FDI, TFP and income disparity shock.

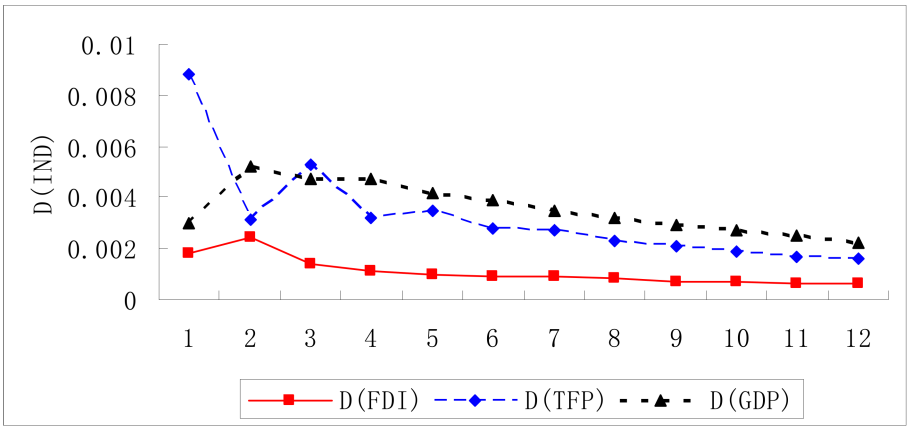

Figure 5. Income disparity response to FDI, TFP and economic growth shock.

To sum up, FDI can affect China's inclusive green total factor productivity, mainly through the following ways. One is that FDI promotes inclusive green total factor productivity through the traditional total factor productivity. But in the process of promoting the traditional total factor productivity, it is accompanied by the expansion of the income disparity and the decrease of environmental pollution. Two, the inflow of FDI will lead to the aggravation of environmental pollution and the enlargement of income disparity, which will reduce the inclusiveness of economic growth and impede the promotion of inclusive green total factor productivity. Three is to promote the economic growth through the inflow of FDI, thus promoting inclusive green total factor productivity. However, the economic growth process will also lead to the expansion of income disparity and a certain impact on the environment, thus reducing the quality of development. Combined with the above three methods, we finally find that China's FDI will play a positive role in inclusive green level and improve the quality of economic development.

With the exception of Zhou et al. (2018), who only focuses on inclusive green growth index, the index has not been widely-discussed before. As a result, our results are not directly comparable with the studies which have mentioned before (Cheng et al. 2011; Li et al. 2013a). As mentioned earlier, these studies found contradictory results with respect to the significance of FDI for Green Total Factor Productivity. We believe that our results cast some light over the underlining reasons for the contradiction. This is because the inclusive green index is concerned not only with "green", but also with income distribution. This is thus a better development index than green growth. Our conclusion

is that FDI can promote inclusive green progress, which can provide experience and support for developing countries to expand their opening up.

5.3. Analysis of Variance Decomposition

Variance decomposition can measure the proportion of the impact of FDI, inclusive green total factor productivity, economic growth, income disparity, traditional total factor productivity, and environmental pollution. Because the generalized variance decomposition is used in this paper, the contribution of the corresponding variables to each phase is not 1. Therefore, in order to clearly measure the relative contribution of each part of the impact, we will standardize the contribution of each phase to make the contribution equal to 1. Table 5 shows the variance decomposition results of the corresponding variables in the fifth, tenth, and fifteenth periods.

Table 5. The results of the generalized variance decomposition of each variable.

Variables	Horizon	IGTFP	FDI	TFP	GDP	POL	IND
IGTFP	5	0.968	0.007	0.011	0.002	0.010	0.002
FDI	5	0.006	0.934	0.005	0.020	0.007	0.028
TFP	5	0.044	0.002	0.938	0.009	0.003	0.004
GDP	5	0.011	0.027	0.066	0.644	0.007	0.245
POL	5	0.005	0.052	0.015	0.003	0.924	0.001
IND	5	0.010	0.006	0.068	0.052	0.004	0.860
IGTFP	10	0.966	0.007	0.011	0.003	0.010	0.003
FDI	10	0.006	0.913	0.006	0.027	0.007	0.040
TFP	10	0.044	0.002	0.934	0.011	0.003	0.007
GDP	10	0.011	0.026	0.079	0.566	0.006	0.311
POL	10	0.005	0.052	0.015	0.003	0.924	0.001
IND	10	0.010	0.008	0.079	0.078	0.003	0.821
IGTFP	15	0.966	0.007	0.011	0.003	0.010	0.003
FDI	15	0.006	0.904	0.007	0.030	0.007	0.045
TFP	15	0.043	0.002	0.931	0.012	0.003	0.008
GDP	15	0.011	0.026	0.086	0.544	0.006	0.328
POL	15	0.005	0.052	0.015	0.003	0.924	0.001
IND	15	0.010	0.008	0.083	0.088	0.003	0.809

Table 5 shows that inclusive green total factor productivity has the greatest contribution to its own impact, followed by traditional total factor productivity and environmental pollution, while the contribution of FDI is relatively small, accounting for only 0.7%. This implies that inclusive green TFP has strong path dependence characteristics, and it is of great significance to maintain the sustainability of inclusive policies. Improving traditional TFP and reducing environmental pollution can promote inclusive green development. In the composition of the traditional total factor productivity impact, the contribution of inclusive green total factor productivity is 4.3%, indicating that maintaining inclusive economic growth will benefit the traditional total factor productivity. The income disparity, the traditional total factor productivity shock contributes about 24%, 6.5%, and 2.5% of the changes in FDI respectively, indicating that China's economic growth is accompanied by greater income inequality. The contribution of FDI to environmental pollution is higher than 5.2%, indicating that the influx of FDI has increased China's environmental pollution to a certain extent. It has been the main factor that impedes inclusive green total factor productivity. The contribution of traditional total factor productivity and economic growth to the income disparity is between 5~10%, and the contribution of inclusive green total factor productivity, FDI and environmental pollution to the income disparity change is relatively small.

6. Conclusions

This paper uses a super-efficient SBM model with two undesirable outputs including income disparity and environmental pollution. We calculate inclusive green total factor productivity and compare the difference between the four TFP of China's provinces (regions). Furthermore, in order to analyze the impact of FDI on inclusive green total factor productivity, this paper establishes a PVAR model and uses the generalized impulse response function and variance decomposition technique to make an empirical analysis. We draw the following conclusions: first, in general, inclusive green TFP < green TFP < inclusive TFP < traditional TFP, traditional TFP is higher than inclusive green TFP by 0.112, and the four types of total factor productivity are gradually decreasing from east to west. Second, FDI can affect the inclusive green total factor productivity of China through different ways. From the final results, FDI is beneficial to the inclusive green total factor productivity of China. Third, inclusive green TFP has strong path dependence. Environmental pollution caused by FDI is an major factor hindering China's inclusive green total factor productivity.

Based on the above conclusions, we give some suggestions for improving China's future inclusive green growth: (1) The degree of pollution in the western region is lower. So this area should commit to the "The Belt and Road" construction which can attract more foreign direct investment. But the government should pay attention to the protection of the ecological environment and avoid the route of "pollution first and then harnessing". While developing the economy, the central and eastern regions should pay more attention to the treatment of environmental pollution. The central government should reform the income distribution system. By improving relevant policies such as "precise poverty alleviation" proposed by China in 2013, it will alleviate poverty and raise labor income (Zhao and Wang 2015); (2) China should gradually improve the access policy of FDI, improve the environmental threshold of FDI, and reduce the environmental preferential policies for the introduction of FDI enterprises. At the same time, it is helpful to guide the FDI to the green industry; (3) As mentioned before, the main source of the income disparity in China is the income gap between urban and rural areas. One reason for the excessive income gap is that farmers' income growth is too slow. The current FDI flows to China are mainly concentrated in the second, third industry, and agricultural FDI accounts for less than 3%. The increase of agricultural FDI, on the one hand, can promote the employment of farmers and raise the income of farmers; on the other hand, it can also increase agricultural development capital and increase the total factor productivity of agriculture (Chaudhuri and Banerjee 2010; Zhang et al. 2016). China should improve the environment of foreign investment for rural areas, actively guide the inflow of FDI into the first industry.

This paper still has some limitations. We only use China as a representative of developing countries to test whether FDI can affect inclusive green development. Therefore, further research should select more developing countries to verify the results. After all, the background and environment of each country are heterogeneous. Additional research can also explore the impact of FDI on inclusive green growth in developed countries or explore whether other factors (such as the degree of openness, the economic institution) can affect inclusive green development.

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