The Effect of FDI on Ecological Efficiency in China's Regional Eco-efficiency under the Third- Country Effects

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Abstract

The paper selects China's statistical data from 2004 to 2016. From the perspective of Third- Country Effects, it uses DEA and spatial measurement analysis methods to study the impact of FDI on China's regional eco-efficiency. The results show that compared with the Third- Country Effects, the impact of FDI on eco-efficiency has a significant change considering the Third- Country Effects. FDI inflows in the eastern region and adjacent regions will have a significant positive impact on the eco-efficiency of the region. In the western region, the impact of FDI accumulation in its adjacent regions on the ecological efficiency of the region also shows a significant positive change, but the level of significance is smaller than that of non-Third- Country Effects and its elasticity coefficient also becomes smaller. Then, based on the empirical analysis results, the suggestions for improving the regional ecological efficiency are put forward, which has certain practical significance for the sustainable development of the regional economy.

Keywords: country, regional, ecological efficiency, FDI

INTRODUCTION

Under the background of increasing global integration, the Chinese economy has achieved rapid development and has become the world's second largest economy. The rapid development of China's economy has attracted a large number of foreign investors. The total amount of outward direct investment has been increasing year by year. As of the end of 2017, the scale of China's use of foreign capital reached 877.56 billion yuan, an increase of 7.9% year-on-year. FDI inflows have become a major driving force for regional economic growth in China, but the inflow of foreign capital has also brought certain pressure on the environment. Economic growth has paid more attention to the speed of economic growth. Over-exploitation of resources has emerged, which has brought greater pressure on the environment. In some areas, it has reached the limit of environmental carrying. Therefore, it is particularly urgent to change the mode of economic growth. It is necessary to pay attention to the quality of economic growth, reduce the pressure on the environment, and achieve a green and healthy economic development. In recent years, China has begun to pay more attention to the quality of foreign investment, increased the introduction of high-tech industries, and restricted the introduction of high-pollution, high-emission, and high-energy-consuming industries, and coordinated the coordinated development of resources, the environment, and the economy. In the new era, more and more scholars have begun to study the impact of FDI on regional ecological efficiency, and the influence of spatial effects of FDI, that is, Third- Country Effects, has become a hot topic for scholars. This paper explores the impact of FDI on regional ecological efficiency from the perspective of Third- Country Effects, and focuses on whether ecological efficiency is affected by FDI and whether FDI distribution outside the region is affected by the ecological efficiency of the region. It is hoped that this will provide a sustainable development for China's regional economy. Certain theoretical evidence provides meaningful conclusions and reference values for achieving sustainable development.

LITERATURE REVIEW

Ecological efficiency is an important indicator to measure the quality of economic development. It is a kind of production state with low input, low energy consumption and high output, and reflects the ecological benefits. The earliest meaning of ecological efficiency is considered to be adapted to the sustainable development of the economy and how to achieve it by

increasing the company's environmental performance, thereby enhancing the company's core competitiveness and level of innovation, Acharyya (2012) on trade The research on the relationship with environmental impact has aroused great repercussions from the academic community and created a research boom in the relationship between FDI and regional environment. Since the 1990s, the scale of FDI inflows to China has been increasing. The influx of FDI has played a huge role in promoting the development of the local economy.

For example, it brought with it funds, technology, and advanced management experience; but it also brought certain The pressure, such as the introduction of high-energy, high-pollution, and high-emission industries, has caused some damage to the environment, reduced the regional ecological efficiency, and is detrimental to the sustainable economic development. Therefore, the impact of FDI on regional ecological efficiency has attracted scholars' extensive attention. Baltagi et al. (2007) used the DEA model to estimate the regional ecological efficiency in China, and analyzed the impact of foreign direct investment on regional ecological efficiency on the basis of this result. The results showed that only the FDI in the eastern region of China had an obvious impact on the regional ecological efficiency. The positive effect of the impact on the Midwest is weaker than that of the eastern region. Chen and Gong (2013) found that direct foreign investment has direct and indirect effects on regional ecological efficiency. The mechanism of indirect effect is to influence regional ecological efficiency by promoting regional economic growth and improving regional environmental technology. Chu and Huang (2012) believes that environmental regulation has two effects on the regional ecological efficiency, and the research results show that after 2003, the regulatory role of environmental regulation becomes weaker and weaker, and even becomes a promotion effect, which is mainly reflected in the strengthening of environmental regulation. Forcing companies to improve environmental technology, increase the proportion of high-tech industries, so as to enhance the regional ecological efficiency. Coughlin and Segev (2000) found that FDI has a positive impact on regional ecological efficiency, which requires certain conditions, that is, environmental regulations must reach a certain level in order to make the technology spillover effect of foreign direct investment more obvious, the level of environmental regulation and the introduction of foreign capital. Quality plays a major

guiding role. Strict environmental regulations will absorb foreign investment projects in high-tech industries and transform the traditional technologies and equipment in the region to improve regional ecological efficiency.

In recent years. As scholars have conducted in-depth studies on the effects of FDI, it has been found that any country is a tiny part of the world, and that FDI's layout in a certain region will be exchanged through resources, technology, information, and talent. The area has an impact. Since the surrounding areas of the layout do not belong to the host country or the home country, the academic community collectively referred to them as "Third Countries/ Third Markets". When Halkos and Paizanos (2013) studied the influence of foreign investment in the host country when investing in neighboring regions increased, he would call it "Third-Country Effects" in the neighboring region, and explained the importance of Third- Country Effects in investment strategy. Helpman et al. (2004) analyzes the general equilibrium of multi-sector and multi-sector to verify the existence of Third- Country Effects. The research results show that transnational companies have an impact on U.S. exports and foreign investment due to Third- Country Effects. Lan et al. (2012) studied the effects of Third- Country Effects with bilateral trade. He believes that the purpose of FDI is to use the host country's cheap resources and labor to save product costs. The arrangement of FDI in neighboring regions of the host country can affect the circulation of factors with the host country. The host country's elements and product prices, and through the spillover effect of technology, affect the host country's trade problems. At the same time, through empirical analysis, it is found that if the Third- Country Effects are omitted, the model's biased estimates will be generated, making the estimation result inaccurate. In short, many studies have discovered the real existence of Third- Country Effects. At this point, the influence of "Third-Country Effects" has been formally named by the academic community as "Third-Country Effects". Coughlin and Segev (2000) used spatial lag variables to verify third- Country Effects. The results showed that the distribution of FDI in different regions was affected by the layout of FDI in its neighboring regions, and there was a significant Third- Country Effects in the distribution of FDI. Hoffmann et al. (2005) used the spatial econometric model to verify the Third- Country Effects of FDI and found that there is indeed a Third- Country Effects in the layout of FDI, but he also found that the spatial econometric model does confirm the existence of a

Third- Country Effects but cannot confirm what the effect is caused. Khalil and Inam (2006) have further developed the spatial econometric model. He believes that it is not possible to consider only spatially lagged variables, but also other control variables that influence the explanatory variables, and incorporate them into an empirical model in order to accurately reflect Third- Country Effects.

In summary, we can find that the academic community has done a lot of research on the impact of FDI on the environment, and some scholars have studied the impact of FDI on regional ecological efficiency. On the Third- Country Effects, scholars mainly verify the existence of Third- Country Effects through spatial measurement. However, under the Third- Country Effects, the impact of FDI on regional ecological efficiency is lacking. Based on this background, this paper mainly studies the impact of FDI on regional ecological efficiency from the following perspectives: (1) Using super-efficiency DEA to measure regional ecological efficiency in China, this method can overcome the effective boundary problem, ie, the ecological efficiency value can exceed 1 for follow-up. Research provides the basis for analysis. (2) Conduct research under the influence of Third- Country Effects, incorporate third- Country Effects into spatial econometric models, analyze the impact of FDI on China's regional ecological efficiency, and more accurately reflect the impact of FDI on regional ecological efficiency. The introduction of Third- Country Effects can be a useful supplement to previous studies and suggest meaningful strategies for improving regional ecological efficiency in China.

RESEARCH METHOD

This project selected the super-efficiency DEA method to measure the ecological efficiency in China's region. This method uses convex analysis and linear programming as tools and relative efficiency as the basis to evaluate the relative effectiveness of the same type of decision unit (DMU) using multi-input and multi-indicator outputs. The DEA method does not require dimensionless data processing. At the same time, it does not require any weighting assumptions before building the DEA model. Instead, the actual data input and output decision unit needs to obtain the optimal weight, which can effectively solve the weighted area problem.

In order to compare regional ecological efficiency in China's provinces, this project divided China into three regions, namely the eastern, central, and western regions, and compared the ecological efficiency of the three regions, with N as the decision-making unit. During the same period, each region in China is a DMU (Decision-making Unit), and each decision-making unit (area) has m inputs (input) and n outputs (output), which represent resources, consumption and output effectiveness. The i unit is denoted as DMU_i (i=1, 2, ..., N), its input and output forms are:

$$X_i = (x_{1i}, x_{2i}, \cdots, x_{mi})^T > 0$$

$$Y_i = (y_{1i}, y_{2i}, \cdots, y_{mi})^T > 0$$

The corresponding weight vector is set to:

$$U = (\mu_1, \mu_2, \cdots, \mu_m)^T \geq 0$$

$$V = (v_1, v_2, \cdots, v_n)^T \geq 0$$

The DMUi efficiency evaluation index is:

$$h_i = \frac{V^T Y_i}{U^T X_i} = \frac{\sum v_r y_{ri}}{\sum \mu_j x_{ji}} (i = 1,2,3,\cdots,N)$$

Assume that the decision unit being evaluated is i0, and DMU_{i0} is recorded. Under the condition that the efficiency index of each decision unit does not exceed one, select the appropriate weight vector U and V to achieve $\frac{V^T Y_{i0}}{U^T X_{i0}}$ The maximum, that is, the optimization model of DMU_{i0} is:

$$\begin{cases} D(X_{i0}, Y_{i0}) = max(\frac{V^T Y_{i0}}{U^T X_{i0}}) \\ s.t. \frac{V^T Y_i}{U^T X_i} \leq 1 \\ U \geq 0, V \geq 0, (i = 1,2,3,\cdots,N) \end{cases}$$

For the traditional DEA model, if multiple decision units are at the same time leading to the production frontier and multiple decision units are simultaneously effective, the model will not be able to further evaluate and compare the merits of effective decision units. Levinson, Taylor (2008) established an investment-oriented super-efficiency DEA model is used to make up for this deficiency, which can make the effective decision unit efficiency value greater than one. The super-efficient DEA (SE-DEA) model is as follows.

$$\begin{cases} D(X_{i0}, Y_{i0}) = max(\frac{V^T Y_{i0}}{U^T X_{i0}}) \\ s.t. \frac{V^T Y_i}{U^T X_i} \leq 1 \\ U \geq 0, V \geq 0, (i = 1,2,3,\cdots,N), i \neq i_0 \end{cases}$$

The advantages of this method are as follows: First, objectivity, avoiding subjective consciousness; Second, DEA method does not need to be normalized; Third, it

Table 1. Input and Output Indicator System

	Index classification		Composition of indicators
Input indicators	Environmental pollution	Wastewater pollution	Wastewater discharge (tons)
			Chemical oxygen demand (tons)
		Exhaust pollution	SO$_2$ emissions (tons)
			Smoke and dust emissions (tons)
			CO$_2$ emissions (tons)
			Dust emissions (tons)
		Solid waste pollution	Solid waste production (tons)
	resource consumption	Energy consumption	Million yuan GDP energy consumption (ton standard coal/ten thousand yuan)
		Water consumption	Total amount of water used (10,000 cubic meters)
		Land consumption	Construction land (square kilometers)
Output indicators	Regional economic growth		Regional GDP

Table 2. Regional Ecological efficiency in China, 2004-2016

Regional	east	Central	west
2004	1.04	0.68	0.61
2005	1.02	0.66	0.66
2006	1.01	0.67	0.65
2007	1.02	0.68	0.64
2008	1.04	0.69	0.59
2009	1.00	0.63	0.57
2010	1.08	0.69	0.59
2011	1.09	0.75	0.63
2012	1.11	0.76	0.65
2013	1.11	0.81	0.65
2014	1.13	0.83	0.68
2015	1.14	0.86	0.75
2016	1.15	0.92	0.82

can reflect the effectiveness of production activities; Fourth, it can provide auxiliary management for producer's information.

Indicator Selection and Data Sources

Ecological efficiency emphasizes the unity of economic value and environmental benefits. In other words, economic development should be based on the premise of low resource consumption and low environmental pollution. Therefore, this topic uses resource consumption and environmental pollution as input indicators. Regional economic growth is an output indicator. The indicator system is shown in **Table 1**.

The input-output data required for the super-efficiency DEA model is mainly based on the "China Statistical Yearbook 2004-2016", "China Environmental Statistics Yearbook", "China Energy Statistics Yearbook" and "New China 50-year Statistics".

Results of Regional Ecological efficiency Measurement in China

Based on the super-efficiency DEA model, relevant data were used to measure the ecological efficiency of each region in China from 2004 to 2016. The results are shown in **Table 2**.

Spatial Econometric Analysis of the Effect of FDI on Regional Ecological efficiency under the Third-Country Effects.

Spatial Autocorrelation Test of Regional Ecological Efficiency

Before using the space panel model for parameter estimation, the exploratory spatial data analysis method (Moran's I index test) was used to determine the spatial autocorrelation of the explanatory variables in each year. Using the related research ideas of Li et al. (2014), we use global Moran's I to verify whether there is a significant spatial agglomeration effect on regional ecological efficiency. The value of global Moran's I is between -1 and 1. For any year, the Moran's I index is calculated as:

$$Moran's\ I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(Y_i - \bar{Y})(Y_j - \bar{Y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}}$$

$$W_{ij} = \begin{cases} 1 & Area\ i\ and\ area\ j\ are\ adjacent \\ 0 & Area\ i\ and\ area\ j\ are\ not\ adjacent \end{cases}$$

where Y_i, Y_j represent the observed value of the i-th or j-th region (eg, ecological efficiency level), and n denotes the number of regions. The Moran's I index reflects the spatial correlation of spatially adjacent variables. Its value is usually between -1 and 1, with greater than 0 being a positive spatial correlation, and

Table 3. Statistics of Ecological Efficiency Moran's I Index from 2004 to 2016

Year	lnEE		Year	lnEE	
	Moran	P value		Moran	P value
2004	0.5412	0.0012	2011	0.5225	0.0036
2005	0.5359	0.0003	2012	0.5269	0.0035
2006	0.5326	0.0018	2013	0.5301	0.0012
2007	0.5369	0.0012	2014	0.5325	0.0005
2008	0.5002	0.0023	2015	0.5356	0.0019
2009	0.5123	0.0014	2016	0.5319	0.0046
2010	0.5236	0.0005			

being less than 0 a negative spatial correlation. The greater the absolute value, the larger the absolute value. Explain that the degree of autocorrelation is large. If it is 0, it is irrelevant. This paper uses regional ecological efficiency as an example to verify its spatial correlation. The results are shown in **Table 3**.

As can be seen from **Table 3**, the Moran's I indices of regional ecological efficiency are all positive, and their sizes are all greater than 0.5, indicating that there is a strong positive spatial effect on regional ecological efficiency, that is, the regional ecological efficiency is not only affected by The influence of regional factors is also influenced by the surrounding areas, such as the impact of resources, talents, information, and technology flowing in the surrounding areas on the region. According to this conclusion, the influencing factors of ecological efficiency in the study area should be the selection of spatial econometric model, which can more accurately reflect the problem.

Third- Country Effects" Test of Ecological Efficiency Affected by FDI

Method selection

Spatial measurement takes into account the mutual influence of spatially adjacent regions. Therefore, when analyzing the effect of FDI on regional ecological efficiency, third- Country Effects should be included in the spatial econometric model. Based on the relevant research of Lee (2009), this paper builds a model that does not include Third- Country Effects and includes Third- Country Effects, focusing on examining the "Third- Country Effects" of FDI's impact on regional ecological efficiency.

Indicator selection and data source description

In this paper, based on data availability, this paper selected 30 provinces from 2004 to 2016 as samples (excluding Hong Kong, Macao, and Taiwan). The data are mainly derived from China Statistical Yearbook, China Labor Statistics Yearbook and The Compilation of New China's Sixty Years of Information is compiled and calculated. At the same time, in order to eliminate the influence of price factors, the data concerning the

value patterns are reduced by the fixed asset investment price index or the consumer price index, and the actual foreign direct investment stock is calculated using the perpetual inventory method.

In order to explore the impact of foreign direct investment on regional ecological efficiency, this paper uses China's regional ecological efficiency (EE) as an explanatory variable. This paper mainly studies the impact of FDI on regional ecological efficiency, and therefore mainly explains the selection of foreign direct investment (FDI). To take into account the accuracy of model analysis, it is necessary to introduce other control variables that affect regional ecological efficiency, mainly including per capita GDP. Per capita GDP reflects the actual effect of economic growth; industrial structure variable (STR), with the added value of the secondary industry accounting for regional production. The total value is expressed as the proportion; the urbanization rate (UR) is expressed as the proportion of the urban population in each city to the total population; the environmental regulation intensity (ERI) is expressed as the proportion of the total amount of the sewage charges collected in each area to the regional GDP. Technological progress (TECH) is expressed by the proportion of R&D spending of large and medium-sized industrial enterprises in each region to GDP.

Model construction

Based on related research by Perkins, Neumayer (2012), this paper constructed two econometric models that do not include Third- Country Effects and include Third- Country Effects, focusing on examining the "Third- Country Effects" of FDI's impact on regional ecological efficiency in China. The traditional econometric models that do not include spatial effects (without "Third- Country Effects") are:

$$LnEE_{i,t} = \alpha_i + \beta_1 LnFDI_{i,t} + \beta_2 LnSTR_{i,t} + \beta_3 LnUR_{i,t} + \beta_4 LnERI_{i,t} + \beta_5 LnTECH_{i,t} + \beta_6 LnGDP_{i,t} + \gamma_t + \varepsilon_{i,t}$$

Among them, t represents the year, i represents the province, EE represents the regional ecological

efficiency, FDI represents the actual foreign direct investment stock, STR represents the industrial structure, UR represents the urbanization rate, ERI represents the environmental regulation, TECH represents the technological progress, α_i and γ_t respectively Representing regional and temporal disturbances, ε_(i,t) represents disturbances. The model only reflects the influence of economic, social, and geographical factors in different regions on the ecological efficiency of the region, regardless of the impact of the surrounding region on the region.

The spatial econometric model containing "Third-Country Effects" is:

$$Lneco_{i,t} = \alpha_i + \beta_1 LnFDI_{i,t} + \beta_2 LnSTR_{i,t} + \beta_3 LnUR_{i,t} \\ + \beta_4 LnERI_{i,t} + \beta_5 LnTECH_{i,t} \\ + \beta_6 LnGDP_{i,t} + \gamma WX_{-i,t} + \gamma_t + \mu_{i,t}$$

$$\mu_{i,t} = \rho W \mu_{-i,t} + \varepsilon_{i,t}$$

$$|\rho| \leq 1$$

where t represents the year, i represents the region, α_i and γ_t represent regional and temporal disturbances, $\varepsilon_{i,t}$ represents the disturbance term, and ρ is the spatial lag factor. The model examines the "Third- Country Effects" of FDI-affected ecological efficiency by introducing the spatially lagged term WX-it for all explanatory variables. If the coefficients of all spatial lag variables are not significant, then there is no " Third-Country Effects "; conversely, if the coefficients of one or more spatial lag variables are significant, then the " Third- Country Effects " cannot be ignored, spatial lag variables The coefficient and significance level reflect the specific direction and effect of the "Third- Country Effects" of each influencing factor.

Estimation results analysis

In this paper, the maximum likelihood method (ML) proposed by Wang et al. (2006) is adopted, and spatial econometric regression analysis is performed using Matlab software. Maximum likelihood estimation (MLE) not only can effectively overcome the estimation errors caused by endogenous problems, but also can scientifically reflect the spatial dependence of ecological efficiency in each region, and accurately measure the influence direction and degree of "Third- Country Effects". The estimated results are as follows:

Variable	East		Central		West	
	NS	WS	NS	WS	NS	WS
lnFDI	-0.006 (4.23)	0.369★ (1.35)	0.369★ (1.39)	0.223★ (1.44)	0.331★★ (2.21)	0.204★★★ (1.25)
lnGDP	0.396★ (1.12)	-0.128 (3.25)	-0.251★ (1.18)	-0.321★★ (2.23)	-0.536★ (1.33)	-0.436★★★ (1.26)
lnSTR	-0.189 (3.69)	0.301 (3.21)	-0.239★ (2.26)	-0.502★★★ (1.33)	-0.192★ (2.52)	-0.123★★★ (1.49)
lnUR	-0.121★ (2.58)	-0.323★★★ (1.51)	-0.661 (4.21)	0.312★ (1.25)	-0.306 (3.33)	0.259★ (1.42)
lnERI	0.116★ (1.48)	0.226★★ (2.23)	0.269★ (1.15)	0.113★ (1.25)	-0.323★★ (1.29)	-0.003 (3.28)
lnTECH	0.398★ (1.58)	0.473★★ (2.22)	0.152★ (1.19)	0.369★★ (2.34)	0.298★ (1.36)	0.409★★★ (1.28)
"Third-Country Effects " variable						
Wlnfdi		0.432★ (2.25)		0.229★★★ (2.36)		0.219★★★ (2.24)
Wlngdp		0.469★ (2.21)		-0.339★★ (1.19)		-0.352★★★ (2.21)
Wlnwg		0.552 (3.21)		-0.456★★★ (2.58)		-0.479★★★ (2.25)
Wlnur		-0.336 (3.26)		0.369★ (2.21)		0.269★★ (2.21)
Wlnrug		0.397★★★ (1.55)		0.302★★ (2.29)		0.332 (3.32)
Wlntech		0.298★★ (2.23)		0.445★★ (2.36)		0.259★★★ (1.39)
AdjR²	0.785	0.996	0.791	0.982	0.785	0.859
Hausman Test	44.2	66.8	41.9	57.2	49.8	79.6
Log L		78.6		67.5		56.3

★★★, ★★, and ★ indicate significant levels at 1%, 5%, and 10%, respectively. Standard deviation in parentheses

From the estimation results, there is a significant "Third- Country Effects "of FDI's impact on China's regional ecological efficiency. From the above table, it can be seen that at least four of the six variables after the inclusion of Third- Country Effects are significant, and the model is fitted. The degree of goodness is higher than that of the Third- Country Effects. It shows that the Third- Country Effects model has a better fitting degree and is more scientific and accurate, which further validates the rationality of the spatial econometric model (Yeaple 2003).

The impact of FDI on regional ecological efficiency

Without regard to Third- Country Effects, foreign direct investment has a significant impact on regional ecological efficiency, but in different regional characteristics, from the estimation results, the distribution of FDI in the central and western regions is positively correlated with ecological efficiency. In other words, the higher the degree of openness to the central and western regions, the higher the ecological efficiency of the region. This shows that foreign capital inflows have a greater impact on the central and western

regions. The economic development in the central and western regions of China lags behind the eastern region. The existing industries are mostly traditional three-high industries. The economic development lacks funds and appropriate projects. Therefore, foreign capital inflows bring sufficient funds and advanced management experience to the local regional economy. Development plays a major role in promoting, at the same time, foreign capital inflows can improve regional technological levels, transform traditional industries, and reduce pollution emissions. Foreign direct investment in the eastern region is negatively correlated with ecological efficiency, ie opening degree will reduce the ecological efficiency of the region, but it is not significant in the model. This indicates that the eastern region is currently experiencing rapid economic development, a high level of urbanization, a relatively high level of technology, a large capital inflow, and a continuous increase in foreign capital inflows. The economic development exceeds the tolerance of the environment and will exert greater pressure on the environment and reduce Regional ecological efficiency, but the level of significance is low, indicating that although there is a negative correlation, it is not obvious.

Considering the Third- Country Effects, the impact of WFDI on ecological efficiency has changed significantly. That is to say, the increase of FDI inflows in neighboring regions will increase the improvement of ecological efficiency in local regions, indicating that the Third- Country Effects are more accurate. Looking first at the eastern region, the FDI inflows from neighboring regions will have a significant positive impact on the ecological efficiency of the region, which means that the accumulation of foreign direct investment in the adjacent regions in the east will indeed contribute to the coordinated development of economic growth and resource and environment in the region and improve the regional ecological efficiency is mainly due to the fact that the concentration of FDI in neighboring regions has a greater demand for high-tech and resources in the region, promotes technological advancement in the eastern region and improves the efficiency of resource utilization, and has a positive and significant effect on regional ecological efficiency.

From the central and western regions, the impact of FDI accumulation in its adjacent regions on the ecological efficiency of the region also shows a significant positive change, but the significance level is smaller than that of non-Third- Country Effects, and its elasticity coefficient also becomes smaller, mainly because FDI agglomeration in neighboring regions has

a major demand for talents, resources, and technologies in the region, and is mainly due to resource demand. Due to the low level of resource development in the central and western regions, resource development in the region will occur when there is a large demand for resources in neighboring regions. It will have some negative impact on the environment, but overall it can still promote the improvement of the ecological efficiency of the region, because although the development of resources has increased, but due to the increasing demand of the neighboring regions for the region, the economic growth in the region has developed rapidly and there can be More funds to improve the environment, and FDI spillovers in neighboring regions are also conducive to the improvement of ecological efficiency in the region. Therefore, the overall ecological efficiency in the central and western regions has increased, but the impact coefficient is smaller than that of Third-Country Effects.

Influence of Other Influencing Factors on Regional Ecological Efficiency
GDP per capita
Regardless of Third- Country Effects, in the eastern region, the coefficient of elasticity of the per capita GDP on ecological efficiency is positive, and the effect on the central and western regions is negative. The eastern region's economic growth pattern is clearly superior to that of the central and western regions. The eastern region places more emphasis on the adjustment of industrial structure, the quality of economic growth, the development of energy-saving and environmental protection industries, and the development of circular economy. These development directions are conducive to the improvement of the ecological efficiency in the eastern region. . Although the economic growth mode in the central and western regions has been greatly improved compared with the previous period, the excessive use of resources and the introduction of heavy pollution industries still exist, which will cause a drop in ecological efficiency. Considering the negative effects of Third- Country Effects, the main reason is that a regional economic development requires a lot of resources as a support, it will inevitably restrict the flow of resources in adjacent areas, hinder the diffusion effect of technology, and occupy the resources of neighboring regions, which is not conducive to Ecological efficiency.

Industrial Structure (STR)
Regardless of the Third- Country Effects, the industrial structure (STR) has negative impact on the eastern region's ecological efficiency, but it does not

pass significant test. This shows that the impact of the industrial structure on the eastern ecological efficiency is negative, but the impact is weak or did not show up. The industrialization in the east is in a period of rapid increase, and the adjustment of industrial structure is reasonable. It has fully exerted industrialization efficiency, improved industrial technological efficiency, thus reduced energy consumption and emissions, and improved regional ecological efficiency. The impact on the central and western regions is negative. The development of industrialization in the central and western regions is relatively lagged. Its economic development depends mainly on industrial development, which increases energy consumption and pollution emissions, and has a negative impact on regional ecological efficiency. Considering the Third-Country Effects, the impact of industrial structure on the ecological efficiency of the central and western regions is positive, mainly because the industrial development of neighboring regions is higher than the region because of its technical efficiency, so the energy demand for this region is low, and because of the adjacent With the development of regional industries, advanced technologies can be spilled over into the central and western regions, so as to enhance the technical level of the region and have a positive impact on the improvement of regional ecological efficiency. However, it has a significant negative impact on the eastern region, mainly because the increase in the proportion of the secondary industry in the eastern adjacent regions is not conducive to the coordination of resources and environment in the adjacent regions, which has a negative impact on the ecological efficiency of the region.

Urbanization (UR)

The impact of urbanization rate on regional ecological efficiency is negative, but failed to pass the significance test in the central and western regions, that is, the impact of urbanization on the ecological efficiency of the central and western regions is not obvious. The main reason is that the current level of urbanization in the central and western regions is low. It has not yet had a significant impact on the regional ecological efficiency, but the further in-depth urbanization will cause ecological efficiency. In the eastern region, urbanization has a significant negative impact on ecological efficiency. The level of urbanization in the east is in a rapid progress phase. Urbanization is accompanied by over-exploitation of resources and energy consumption, which leads to a decline in ecological efficiency. Considering the Third-

Country Effects, there are significant negative efficiencies in all three regions, and the level of significance is much higher. Mainly urbanization in the adjacent areas of the area will over-exploit resources and attract resources in the region to cause environmental problems.

Degree of Environmental Regulation (ERI)

Without considering Third- Country Effects, the regression coefficient of environmental regulation intensity is significantly positive in the eastern and central regions, but significantly negative in the western region. In this paper, the total amount of sewage charges represents the intensity of environmental regulations, which means that when the total amount of sewage charges is increased to a certain level, it will have a negative impact on regional economic development. For example, lack of development funds, the western region will increase energy consumption and pollution due to development. Emissions need to be turned over to a relatively large amount. This will have a negative impact on the economic development and ecological and environmental protection in the western region, and it will even have the opposite effect. Considering the Third- Country Effects, the impact of environmental regulation on the mid-eastern impact of ecological efficiency is positive, and the coefficient of influence increases. This shows that after considering third- Country Effects, environmental regulation has a stronger influence on regional ecological efficiency due to the adjacent regions' increased environmental regulation places high demands on the resources and technical or product technological content of the region. This requires a higher level of environmental protection research in the region, which will increase the regional ecological efficiency. The impact on the west is negative, but the level of significance is significantly reduced. The elasticity coefficient has obviously become smaller, which indicates that the more stringent the environmental regulation in the neighboring regions is, the higher the technical requirements for the western region are, and the higher the environmental protection requirements, the more the western region can be forced to improve the ecological efficiency.

Technical level (TECH)

Judging from the estimation results, regardless of whether or not the Third- Country Effects technology is considered, the impact on the regional ecological efficiency is significant and positive, because the improvement of the technology level can improve the efficiency of resource utilization and reduce the

emission of pollution. At the same time, it can be seen that the impact intensity is improved under the influence of the Third- Country Effects, because the improvement of technology level in neighboring regions will create a technology spillover effect in the region, thereby enhancing the technical level of the region, thereby enhancing the regional ecological efficiency.

CONCLUSIONS AND SUGGESTIONS

Conclusion

This paper combines theoretical analysis and empirical analysis to show that there is a significant Third- Country Effects of FDI on China's regional ecological efficiency. Without considering Third-Country Effects, foreign direct investment has a significant impact on regional ecological efficiency, but in different regions. With different characteristics, the distribution of FDI in the central and western regions is positively correlated with the ecological efficiency. Foreign direct investment in the eastern region has a negative correlation with ecological efficiency. That is, the degree of openness will reduce the ecological efficiency of the region, but it is not significant in the model; considering the Third- Country Effects, the impact of FDI on ecological efficiency shows a significant change. FDI inflows in the eastern and neighboring regions will have a significant positive impact on the ecological efficiency of the region. FDI gathers in its neighboring regions from the central and western regions. The impact on the ecological efficiency of the region also shows a significant positive change, but the level of significance is smaller than that of non-Third- Country Effects and its elasticity coefficient is also smaller.

Suggestions

(1) China's regional ecological efficiency differences are significant and there is more room for improvement. Therefore, we must strengthen the construction of ecological civilization, improve the quality of economic growth, reduce the development of the three high-level industries, adhere to the road of sustainable development, and enhance regional ecological efficiency. The economy in the eastern region is far ahead of the central and western regions. It should increase investment in R&D, develop international advanced environmental protection technologies, and spread technology to the central and western regions to promote regional ecological efficiency throughout China. At the same time, the proportion of high-tech industries should be increased.

Priority will be given to the development of modern manufacturing services with advanced manufacturing capabilities, reducing the impact on the ecological environment and achieving green and healthy development. The ecological efficiency in the central and western regions is relatively low. First, rational and scientific use of resources, such as the development of energy resources, water resources and land resources, etc., follow the principle of appropriateness, improve the level of environmental regulation, strictly supervise the high-tech industries, and improve the unit's resources and environment. Input economic output. Second, according to the needs of its own ecological environment, it is necessary to rationalize the distribution of industries within the region, reduce the distribution of the three high industries, increase the distribution of high-tech industries and modern service industries, and select economic development projects from low carbon and environmental protection to avoid the destruction of the ecological environment.

(2) The empirical analysis of this paper shows that China's regional ecological efficiency has significant spatial correlation characteristics, so we should consider the economic and geographical relationship between regions, and build a cooperative mechanism for coordinated development of resources, environment, and economy. First, through the establishment of the flow mechanism of the factor field, the eastern region has absolute advantages in talents, technology, information, and funds. The eastern region should actively expand these elements to the west and improve the regional ecological efficiency in the west. At the same time, the central and western regions should also seize the opportunity for the rise of the central region and the development of the western region and actively strengthen exchanges and cooperation with the eastern region. Through learning, introducing, absorbing, and utilizing the eastern resources, the development of the clean industry in the region will be promoted, and the ecological efficiency of the region will be further enhanced. Second, according to the regional ecological civilization construction status, ecological efficiency level, and diffusion effects, targeted development of energy conservation and environmental protection policies suitable for the development of the region will be targeted, and supervision will be strengthened to achieve green and healthy economic development and improve the ecological efficiency of the region (Wu et al. 2017).

(3) Actively adopt policies to rationally use foreign capital. Each regional government should formulate

policies for the introduction and utilization of foreign capital in accordance with the needs of its own ecological construction. On the one hand, consideration should be given to the "U" characteristics of FDI. Although foreign investment will initially have a negative impact on the ecological environment, if the policy is implemented properly, the quality of investment promotion will be strengthened, the U-turn point will be smoothly transitioned, and FDI will be implemented on the regional ecology. The benign influence. On the other hand, the regions should make good use of space spillover effects and demonstration effects, make full use of the advantages brought about by the advantages of neighboring regions and technologies, and promote their regional ecological environment through extensive exchanges and cooperation so as to promote regional ecology. The further improvement of efficiency.

(4) Strengthen the industrial and regional orientation of foreign capital introduction. Most of China's FDI flows into the eastern region where the economy is developing well and is extremely unevenly distributed in the east, west, and west. Although this promotes the further development of the eastern region's economy, it also gives the environment in the eastern region. Bringing greater pressure, the empirical analysis of this paper also shows that FDI's positive impact on the eastern region is less significant. Therefore, it is necessary to balance the distribution of FDI in the eastern, central and western regions of China. Therefore, the eastern, central and western regions of China should actively adjust their respective policies to strengthen the industrial and regional orientation of attracting investment. The eastern region should continue to exert its unique regional advantages, give priority to the introduction of high-tech industries and modern service industries, reduce the proportion of the secondary industry, and achieve a healthy economic development. The central and western regions should rely on the country's preferential policies, increase the degree of opening up, attract high-tech industries to the mid-west, and drive the transformation and transformation of industries in the region through foreign direct investment, thereby stimulating the technological content of industrial development in the central and western regions and improving the construction of ecological civilization. To achieve improved regional ecological efficiency.

ACKNOWLEDGEMENTS

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