Research on the Relationship between Green Development and Fdi in Jiangxi Province

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Abstract: Firstly, based on factor analysis method, this paper obtained the green development comprehensive index and its changing trend of 11 prefecture level cities in Jiangxi Province. Secondly, by calculating Moran's I index, it made an empirical analysis of the spatial correlation of FDI between 11 prefecture level cities in Jiangxi Province, both globally and locally. Finally, this paper further tested the relationship between FDI and green development index by establishing multiple linear regression equation. The results show that the overall green development level of Jiangxi Province shows a steady upward trend, but the development gap between 11 prefecture level cities in Jiangxi Province is large, and the important green development indicators have a significant positive impact on FDI.

1. Introduction

As one of the important provinces rising in Central China, Jiangxi has made remarkable achievements in the protection of ecological environment and the promotion of economic benefits while vigorously promoting green development and actively introducing FDI. Data shows that since the first batch of FDI was introduced in 1984, Jiangxi Province has attracted 12.57 billion US dollars of FDI in 2018, with an average annual growth rate of 19.42%. By the first three quarters of 2019, Jiangxi's actual use of FDI amounted to 9.79 billion US dollars, an increase of 8.1%, ranking at the top of the country. However, with the rapid growth of FDI in Jiangxi Province, there are significant differences between the quality characteristics of FDI and the level of green development among 11 prefecture level cities in Jiangxi Province. Therefore, the study of FDI and its impact on the green development level of all cities in Jiangxi Province is conducive to narrowing the gap between them and promoting the overall promotion of Jiangxi Province's opening-up level and comprehensive economic competitiveness.

The domestic and foreign academic circles have taken green economy and green development as the research focus. In foreign countries, Nimubona [1] et al. studied the relationship between technology transfer and border tax adjustment by establishing a general equilibrium model of technology transfer between the two countries. The results show that green technology transfer and border tax adjustment are not always complementary. Jaeho Lee [2] et al. established the international trade model of heterogeneous enterprises, based on the FDI data of South Korea from 1999 to 2006, empirically analyzed the influence of five related attributes of industries with comparative advantage in the host country on the strategic motivation and corporate income of multinational companies. The results showed that the industrial comparative advantage of the host country is one of the important factors that affect the decision-making of transnational M & A or green space of multinational companies. Grinevich [3] and others combined green logic with existing economic and social logic by discussing the strategies of entrepreneurial teams in the sharing economy to deal with various complex components and structural expectations. The results showed that the sharing platform can help to develop underutilized resources. In China, Huo Weidong [4] and other scholars have empirically studied the spillover effect of FDI in the host country by using China's urban panel data. The results show that China should actively guide the transformation of FDI from the spillover effect of productive innovation to the spillover effect of

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ecological innovation. Xu Jianzhong [5] et al. discussed the sustainability of regional development by establishing j-sbm model, kernel density function model and panel model. The results showed that regional sustainable development was closely related to regional environmental regulation, innovation network efficiency and FDI knowledge spillover. Hao Shushuang [6] et al.analyzed the influence of technology, economic structure and environmental policies on green development based on China's inter provincial green development index from 2006 to 2014 by building the evaluation index system and spatial dobin model of regional green development. The results showed that high-tech innovation ability has a promoting role on Regional Green development, while FDI and strict environmental regulations have a promoting role on Eastern green development. The effect is better than that of central and western regions.

It can be seen from the existing research that, in the process of advocating green economy and green development, there are few studies focusing on the impact of FDI on the green development of regional cities. The main reason is that many mathematicians are still in the initial stage of exploring and analyzing the green development level of counties and cities within the province, and because of the unbalanced development of each region, it needs differentiated empirical evaluation to provide a beneficial development path for the green transformation of cities. Therefore, on the basis of the previous literature research, starting from the existing green development index evaluation system in China, this paper analyzes the level and quality of green development in Jiangxi Province according to the requirements of economy, society and environment, in order to provide useful reference value for the green development strategy of Jiangxi Province.

2. Construction of Green Development Evaluation System and Empirical Analysis

2.1 Construction of Evaluation System

As shown in Table 1, on the basis of 2017 / 2018 - China green development index report - regional comparison, this paper selects the required urban green development evaluation indicators, and collects the relevant statistical data from 2000 to 2018 (the data comes from Jiangxi statistical yearbook and the bulletin of national economic and social statistics issued by various cities).

Table 1 Evaluation Index System of Urban Green Development

System level A	Factor level B	Index level C	Index properties
Green development in Jiangxi Province Evaluation index system	Strength of eco city construction B1	Gross domestic product C1	+
		GDP per capita C2	+
		Per capita disposable income of urban residents C3	+
		Urbanization rate C4	+
		Green coverage area C5	+
		Green area C6	+
	Industrial environment friendliness B2	Industrial wastewater discharge C7	-
		Discharge of industrial solid waste C8	-
		Industrial emissions C9	-
		Proportion of tertiary industry in GDP C10	+
	Development level of circular economy B3	Energy consumption of industries above Designated Size C11	-
		Treatment capacity of wastewater treatment facilities C12	+
		Comprehensive utilization of solid waste C13	+
		Treatment capacity of waste gas treatment facilities C14	+
		Number of public transport vehiclesC15	+
	Technological innovation level B4	Total number of Public Library warehouses C16	+
		Local education expenditure C17	+
		Total number of patents authorized in the whole year C18	+
		The ratio between the number of students in college and the total population C19	+

In this paper, factor analysis method is used to establish the evaluation index system of green development level in Jiangxi Province. As a technique of data simplification, factor analysis can express the basic structure of observation data with fewer new variables, and require new variables to reflect the main information of original variables. According to the requirements of kmo test and Bartlett sphericity test, when the kmo value is greater than 0.7, the higher the factor contribution rate is, the better the analysis effect is; when the kmo value is less than 0.5, the worse the analysis result is, which is not suitable for factor analysis. In the process of data standardization, the original data needs to be transformed linearly to map the result to the [0, 1] interval. Using the method of variance maximization, the factor load is rotated orthogonal, and the variance contribution degree of each factor is obtained from the extracted rotation factor, so as to calculate the green development index. The calculation formula of factor analysis method is as follows:

$$x = \alpha_1 F_1 + \alpha_2 F_2 + \cdots + \alpha_i F_i + \varepsilon_i \tag{1}$$

Among: $\alpha_i = \frac{\lambda_i}{\sum_{k=1}^{p} \lambda_k}, (i = 1, 2, \ldots, p)$.

In formula (1) F_i is the score of factor I, α_i is the weight of the i-th factor, λ_i is the variance contribution of the ith factor, ε_i is the special factor that is not included.

2.2 Calculation and Analysis of Evaluation Results

The results of SPSS software showed that kmo value was 0.780 and Bartlett's sphericity test factor analysis was $p < 0.0000$, which indicated that factor analysis was effective. In factor analysis, when the eigenvalue is greater than 1, five factors are obtained, and the cumulative contribution rate of the five main factors is 75.78%. According to formula (1), the green development index of Jiangxi Province is calculated by the weight of five main factors.

As shown in Figure 1, the green development index of all cities in Jiangxi Province in 2000 is less than 0, indicating that the green development level of all cities in 2000 is relatively low; in 2018, the green development index of all cities in Jiangxi Province is greater than 0, indicating that the green development level of all cities in Jiangxi Province is increasing year by year; among them, the green development indexes of Nanchang, Ganzhou and Shangrao are greater than 1, and are similar to other cities. There is a certain gap in urban areas, which shows that the progress of ecological protection and green development of these three prefecture level cities is slightly higher than that of other regions.

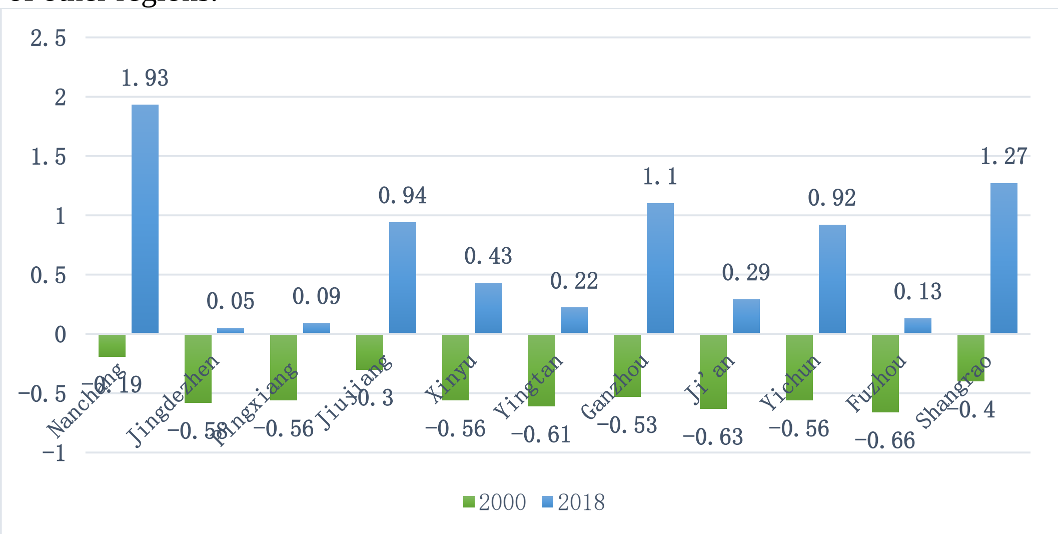

Figure 1 Green Development Index of Jiangxi Province in 2000 and 2018

As shown in Figure 2, from the average value of urban green development index, Nanchang City has the highest average value of 0.78 among the 11 prefecture level cities in Jiangxi Province, indicating that the green development level of Nanchang city is obviously superior to other cities; Yingtan City has the lowest green development level, indicating that the city needs to further strengthen the construction of green ecological civilized city and improve the green quality of the city.

From the perspective of the volatility of urban green development index, among the 11 prefecture level cities in Jiangxi Province, the standard deviation of Nanchang's green development index is the largest, indicating that the dispersion of Nanchang's green development index is greater than other cities; the standard deviation of Yingtan's green development index is the smallest, indicating that the dispersion of Yingtan's green development index is less than other cities.

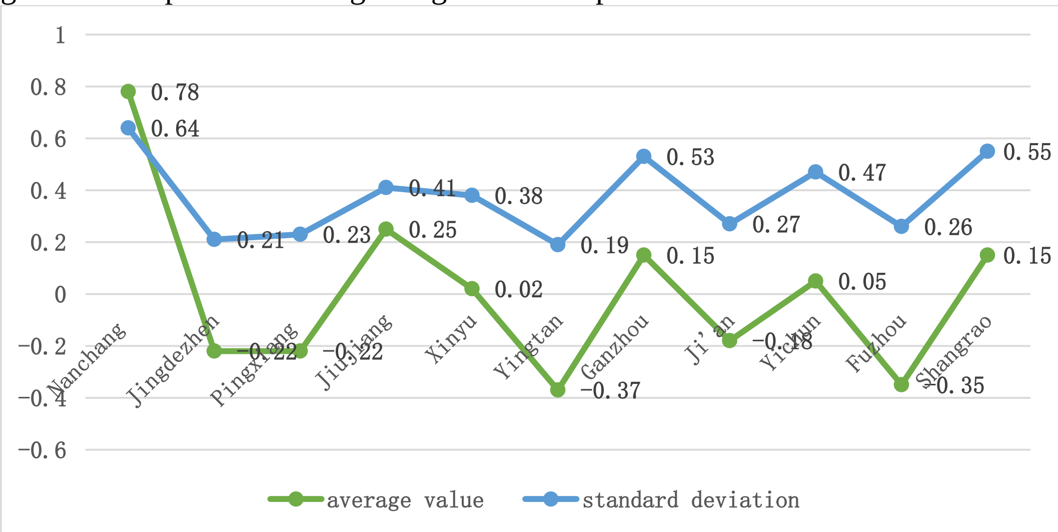

Figure 2 Average Value and Standard Deviation of Green Development Index of Jiangxi Province in 2000-2018

3. Spatial Autocorrelation Analysis of Fdi

3.1 Global Spatial Autocorrelation

In this paper, the global Moran's index is used to measure the global spatial autocorrelation of FDI in Jiangxi Province. Moran's I values are generally distributed in [- 1, 1]. When the value is greater than 0, it means that the data is positively correlated in space. When the value is larger, the spatial correlation is more obvious. When the value is 1, it means that the data is negatively correlated in space. When the value is smaller, the spatial difference is more obvious. When the value is - 1, it means that the data is negatively correlated in space. When the value is 0, it means that the data is uncorrelated. The Moran's I index is calculated as follows:

$$I = \frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} \sum_{i=1}^{n}(x_i - \bar{x})} \tag{2}$$

Among $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$.

In formula (2), I I s Moran's I index, which represents the spatial weight, is the value of region I, and is the value of region J.

The results of the global spatial autocorrelation test of FDI from 2000 to 2018 in Jiangxi Province are shown in Table 2.

Table 2 Global Moran's Autocorrelation Coefficient of Fdi in Jiangxi Province from 2000 to 2018

Particular year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Global Moran index	0.0238	-0.0896	-0.0189	-0.0625	-0.1301	-0.1271	-0.1392	-0.1355	-0.1472	-0.1390
Particular year	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Global Moran index	-0.1241	-0.1190	-0.0969	-0.0738	-0.0664	-0.0646	-0.0649	-0.0650	-0.0799	

Table 2 shows that only in 2000, the global Moran's index is greater than 0, indicating that FDI in Jiangxi Province has a positive spatial correlation in 2000, and FDI shows the characteristics of spatial agglomeration in Jiangxi Province; from 2001 to 2018, the global Moran's index is less than 0, indicating that FDI in Jiangxi Province has a negative spatial correlation during this period, and FDI shows a trend of spatial diffusion in Jiangxi Province. However, from 2001 to 2018, the global Moran's index is greater than - 0.2, indicating that there is a weak negative correlation between FDI and the geographical location of cities in Jiangxi Province.

3.2 Local Spatial Autocorrelation

In this paper, we use the local Moran's index to observe the local spatial distribution of FDI in Jiangxi Province. The local Moran's I index is calculated as follows:

$$I_i = \frac{n^2}{\sum_i \sum_j w_{i,j}} \times \frac{(x_i - \overline{x}) \sum_j w_{i,j} (x_j - \overline{x})}{\sum_j (x_j - \overline{x})^2} \tag{3}$$

In formula (3) i s the local Moran's I index of region I, where $\sum_{i=1}^{n} I_i = n \times I$.

According to the law of local Moran's I index and Moran scatter diagram, the first quadrant (HH region) has the characteristics of high spatial unit observation value and high spatial connection between adjacent regions, the second quadrant (LH region) has the characteristics of low spatial unit observation value and high spatial connection between adjacent regions, and the third quadrant (ll region) has the characteristics of low spatial unit observation value and high spatial connection between adjacent regions. The fourth quadrant (HL region) has the characteristics of high spatial unit observation value and low spatial connection between adjacent regions.

As shown in Table 3, from 2000 to 2018, the local Moran's I index of 11 prefecture level cities in Jiangxi Province is significantly different from that of surrounding cities every ten years. Molan scattered points of Nanchang, Jiujiang and Ganzhou are all distributed in the fourth quadrant, which shows that the three cities have strong ability to attract FDI and are negatively related to the surrounding cities; Molan scattered points of Jingdezhen, Yingtan and Fuzhou are all distributed in the third quadrant, which shows that the three cities have weak ability to attract FDI and are negatively related to the surrounding cities; Pingxiang Moran scatter of Yichun City and Yichun city are all distributed in the second quadrant, which shows that the three cities have weak ability to attract FDI and are positively related to the surrounding cities; Moran scatter of Xinyu City is firstly transferred from the second quadrant to the first quadrant, then from the first quadrant to the second quadrant, which shows that its ability to attract FDI is first weak, then strong and then weak and positively related to the surrounding cities; Ji Moran scatter of an City, from the first quadrant to the second quadrant, shows its ability to attract FDI from strong to weak, positive correlation with the surrounding cities; Moran scatter of Shangrao City, from the third quadrant to the fourth quadrant, shows its ability to attract FDI from weak to strong, negative correlation with the surrounding cities.

Table 3 Local Moran Index of Fdi in Jiangxi Province in 2000, 2009 and 2018 and the Quadrant of Moran Scatter

	2000	2009	2018
Nanchang	-0.328(HL)	-1.857(HL)	-1.207(HL)
Jingdezhen	0.292(LL)	-0.380(LL)	-0.686(LL)
Pingxiang	0.082(LH)	0.146(LH)	0.106(LH)
Jiujiang	-0.188(HL)	0.195(HL)	0.482(HL)
Xinyu	0.034(LH)	-0.012(HH)	0.097(LH)
Yingtan	0.587(LL)	0.686(LL)	0.467(LL)
Ganzhou	-0.279(HL)	-0.446(HL)	-0.151(HL)
Ji'an	0.069(HH)	0.037(LH)	0.035(LH)
Yichun	0.052(LH)	0.042(LH)	0.073(LH)
Fuzhou	-0.150(LL)	-0.490(LL)	-0.448(LL)
Shangrao	0.194(LL)	-0.057(LL)	0.003(HL)

4. Establishment and Analysis of Multiple Linear Regression Model

4.1 Model Setting and Variable Description

In this paper, the per capita GDP, green coverage area, green area, the proportion of tertiary industry in GDP and the total number of patents authorized in the whole year are selected as independent variables and FDI as dependent variables. The model is built as follows:

$$\text{FDI}_{ij} = \beta_1 gdp_{ij} + \beta_2 gca + \beta_3 ga + \beta_4 ind + \beta_5 pat + \varepsilon_{ij} \qquad (4)$$

In formula (4), gdp is the per capita GDP, gca is the green coverage area, ga is the green area, ind is the proportion of the tertiary industry in GDP, pat is the total number of patents authorized in the whole year. ε_{ij} is a random error term

4.2 Model Solution and Analysis

Through calculation, the calculation results of relevant variables are shown in Table 4:

Table 4 Calculation Results Of Relevant Variables

variable	coefficient	P value
gdp	0.02	0.8463
gca	1.06	0.5694
ga	39.46	0.0000
ind	278.44	0.7712
pat	16.89	0.0000
R^2	0.827515	
F	194.783	

The multiple linear regression model is as follows:

$$\text{FDI}_{ij} = 0.02 gdp_{ij} + 1.06 gca + 39.46 ga + 278.44 ind + 16.89 pat - 6770.57 \qquad (5)$$

It can be seen from the statistical results and the equations that other conditions are assumed to be unchanged, $\beta_1 = 0.02$ means that for every 1 unit increase in per capita GDP, FDI will increase by an average of 0.02 units; $\beta_2 = 1.06$ means that for every 1 unit increase in green coverage area, FDI will increase by 1.06 units; $\beta_3 = 39.46$ means that for every 1 unit increase in green area, FDI increases by 39.46 units; $\beta_4 = 278.44$ means that for each unit increase in the proportion of added value of the tertiary industry to the GDP, FDI will increase by 278.44 units; $\beta_5 = 16.89$ means that for every unit increase in the total number of patents authorized in the whole year, FDI increases by 16.89 units.

The ratio of per capita GDP, green coverage area, green area, value-added of the tertiary industry to the regional GDP and the cumulative number of patents authorized in the whole year in 11 prefecture level cities of Jiangxi Province have positive influence on the regional difference of FDI, which shows that the improvement of the four factors is conducive to improving the attraction of FDI to a certain extent and providing good development opportunities for foreign investors.

5. Conclusions and Suggestions

First of all, this paper defines the green development indicators of 11 prefecture level cities in Jiangxi Province, and constructs the green development indicator system framework of Jiangxi Province by using the statistical data of prefecture level cities from 2000 to 2018; secondly, this paper uses Moran's I index to calculate the global spatial autocorrelation and local spatial autocorrelation of FDI distribution in prefecture level cities in Jiangxi Province. Finally, this paper uses multiple linear regression model to explore the relationship between FDI and five important green indicators. The results show that: from 2000 to 2018, the overall green development level of Jiangxi Province is on the rise year by year, but the gap between the green development level of each prefecture level city is obvious; the per capita GDP, green coverage area, green area, the ratio of the added value of the tertiary industry to the regional GDP and the increase of the total number of patent authorizations in the whole year are conducive to promoting the green development water in the local region. Ping.

On the whole, cities in Jiangxi Province have made some achievements in exploring green city construction. The strength of ecological city construction, the degree of industrial environment friendliness, the level of circular economy development and the level of scientific and technological innovation are increasing year by year, which is conducive to promoting the construction of ecological livable living environment in Jiangxi Province and improving people's happiness and living standards. Specifically, all cities in Jiangxi Province show a “spindle” distribution on the level of green development, that is, only Nanchang city is at the upstream level, and the other 10 prefecture level cities are at the middle and downstream level. There is a large gap in the level of green development between cities at all levels, so it is necessary to strengthen cooperation and make rational use of the technology spillover effect of FDI, so as to narrow the gap in industrial introduction, urban construction, science and education level and talent concentration, and shape a new pattern of regional coordinated development.

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