Pol. J. Environ. Stud. Vol. 32, No. 1 (2023), 611-625
DOI: *10.15244/pjoes/153425* ONLINE PUBLICATION DATE: 2022-12-19

Original Research

The Impact of Two-Way FDI on Green Development Quality of the Logistics Industry – Based on the Threshold Effect of Environmental Regulation

Minjie Li[1], Mengjun Meng[2], Kai Huang[2], Xinyu Xie[2], Yihui Chen[3]*

[1]School of Economics and Trade, Fujian Jiangxia University, Fuzhou, China
[2]School of Economics and Management, Fuzhou University, Fuzhou, China
[3]Anxi College of Tea Science, Fujian Agriculture and Forestry University, Fuzhou, China

Received: 10 July 2022
Accepted: 1 September 2022

Abstract

As the main way of international capital flow and an important carrier of international technology spillover, have inward foreign direct investment (IFDI) and outward foreign direct investment (OFDI) improved the green development quality of the logistics industry? Based on the panel data of 27 provinces in China from 2006 to 2015, this paper uses the panel model to empirically test the impact of two-way FDI on the green development quality of the logistics industry. This paper mainly draws the following research conclusions: (1) Two-way FDI had significantly improved the green development quality of the logistics industry, and the promotion effect of IFDI was stronger than that of OFDI, indicating that two-way FDI is a key approach of enhancing the quality of the green development. (2) The impact of two-way FDI on the green development quality has spatial-temporal heterogeneity. Specifically, only in the eastern region, IFDI and OFDI have played a significant role in promoting the green development of the logistics industry at the same time; the role of IFDI in improving the green development quality of the logistics industry has weakened over time, while OFDI has strengthened. (3) The effect of two-way FDI on the green development quality of the logistics industry was affected by the environmental regulation intensity. With the improvement of environmental regulations intensity, the impact of IFDI on the green development quality of the logistics industry presents an "inverted U" trend that first rises and then decreases. The impact of OFDI on the green development quality of the logistics industry presents a gradually increasing characteristic.

Keywords: logistics industry, IFDI, OFDI, green development quality, environmental regulation

*e-mail: cyh_fafu@qq.com

Introduction

Currently, global warming caused by greenhouse gas emissions has seriously affected the sustainable development of human society [1]. In order to effectively deal with global warming, China has proposed to achieve the goal of "peak carbon dioxide emission and carbon neutrality" (hereinafter referred to as "dual carbon" goals), that is, China has announced that it would aim to achieve peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060. As a basic and strategic industry, logistics industry has an important impact not only on economic performance but also on environmental sustainability [2, 3]. Green practices in logistics operations are an important solution to control air pollution and global warming [4]. However, China has achieved rapid development of the logistics industry at the expense of excessive energy consumption and deterioration of the ecological environment [5]. In 2020, China's logistics industry has consumed energy of 413.09 million tons of standard coal, accounting for about 9% of the total energy consumption. The greenhouse gases such as carbon dioxide generated by energy consumption resulted in tremendous damage to the environment. In order to cope with global climate change and realize the "dual carbon" goals as soon as possible, China adheres to the concept of green development. Specifically, the logistics industry, as one of the industries with high energy consumption, also needs to practice the concept of green development, transform from the "black development track" to the "green development road", and enhance the green development quality. Existing literature indicates that green logistics significantly improve social performance, financial performance and environmental performance [6]. Therefore, how to improve the green development quality of the logistics industry is an issue worth thinking about.

Technological progress is an important driving force for green development [7]. Under the condition of open economy, international technology spillover has become an important way to improve a country's scientific and technological level, and inward foreign direct investment (IFDI) and outward foreign direct investment (OFDI) are the main channels and important carriers of international technology spillover [8, 9]. Two-way FDI (IFDI and OFDI) will play an increasingly important role during industry green development. In fact, its significant effects have been verified [10, 11]. With the gradual formation of China's "world factory" status and the deepening of the global supply chain, multinational corporations layout and operate the production network in China, thus attracting international logistics enterprises to enter, and inward foreign direct investment has gradually infiltrated into China's logistics industry. China's logistics industry has witnessed an increase in IFDI from US$1.273 billion in 2004 to US$4.999 billion in 2020. At the same time, the reestablished logistics development model followed by the global economic integration urgently calls for Chinese local logistics enterprises to "going out", actively conduct outward foreign direct investment, and make overall layout of global logistics networks. The OFDI in China's logistics industry increased from US$828.7 million in 2004 to US$6.233 billion in 2020.

With the continuous growth of the scale of two-way FDI in China's logistics industry, the following thoughts are triggered: (1) How to measure the green development quality of the logistics industry. (2) Has two-way FDI exerted a positive impact on the green development quality of the logistics industry? (3) Is there a threshold effect on the impact of two-way FDI on the green development quality of the logistics industry? The answers to the above questions will help to grasp the real situation of the green development quality of China's logistics industry, and correctly view the role played by two-way FDI in the process of green development of the logistics industry. Additionally, the answers can provide a reference for the government to effectively formulate reasonable logistics industry development policies, and have important theoretical and practical significance for China to achieve the "dual carbon" goals and the green and low-carbon transformation of the logistics industry.

Literature Review and Research Hypothesis

Green Development Quality

Kasztelan [12] pointed out that green development which contributes to rational utilization of natural capital, prevents and reduces pollution, and creates chances to improve the overall social welfare. The green development of the logistics industry actually expands and manifests green development in the field of logistics. The green development of the logistics industry is the introduction of environmentally sound principles in logistics activities to save energy and resources, reduce adverse impacts on the environment, and improve corporate performance at the same time [13]. Wang et al. [14] pointed out that green development of the logistics industry aims to reduce the negative impact of logistics activities on the environment and realize the harmonious development of the economy, society and environment, that is, green development of the logistics industry highlights the unification of economic, social and environmental benefits. Zhang et al. [15] pointed out that the green development of the logistics industry emphasizes the realization of logistics and economic development while saving resources and protecting the environment. Gan et al. [16] believed that the essence of green logistics is to pursue economic benefits without destroying the ecological environment, and to realize the "two-wheel drive" of economic and social development and ecological environmental protection. Although there are different definitions, green development of the logistics industry has a few

basic motivations and goals, that is, the pursuit of economic benefits while saving energy and protecting the environment [17]. Therefore, this study defines the green development of the logistics industry as: carrying out logistics activities in an eco-friendly way, making full use of logistics resources, reducing the damage to the environment caused by logistics activities, and achieving a win-win situation between economic and environmental benefits. The green development quality of the logistics industry is a comprehensive evaluation of the green development of the logistics industry. It not only involves the total amount of the logistics economy, but also needs to take into account resource utilization and environmental costs. That is, the improvement of the green development quality of the logistics industry not only means the expansion of the scale of the logistics industry, but also the improvement of the output efficiency of resources and the reduction of environmental pollution.

There are two main approaches to measure the green development quality. First, green total factor productivity (GTFP) can be deemed as an agent indicator of the green development quality. The measurement of GTFP is generally conducted by selecting input indicators, desirable output indicators and undesirable output indicators through DEA method to calculate. Wang and Xin [18] adopted the GML index based on the SBM direction distance function to measure the logistics industry's ecological total factor energy efficiency. Li and Wang [19] used the EBM-GML model including unexpected output to estimate the GTFP of the logistics industry in 30 provinces in China from 2005 to 2017. Secondly, part of the literature applied the "logistics performance index" (LPI) published by the World Bank to measure and evaluate the performance of the logistics industry [20, 21]. The Driving-Force-Pressure-State-Impact-Response (DPSIR) evaluation system proposed by OECD organization is widely used in the academia. Kim et al. [22] selected 12 indicators to measure the green development level of 30 countries and regions based on DPSIR framework. Chen et al. [23] measured the level of low-carbon logistics development in Beijing according to DPSIR framework through entropy weight method.

IFDI and the Green Development Quality

IFDI has a promoting and inhibiting effect on the green development quality of the logistics industry. On one hand, IFDI restrains the green development quality of the logistics industry. First, IFDI may exert a crowding-out effect on domestic investment. Under the precondition of established investment opportunities and resources in the host country, domestic enterprises with weak competitiveness may be dispelled out of the market by foreign enterprise with stronger financing and technical power, resulting in domestic investment squeezed out of the market, exacerbating the financing constraints on domestic enterprises, and reducing economic activities [24]. In the long run, the crowding-out effect will impair local logistics enterprise competitiveness and their development in technological innovation. Secondly, IFDI has a competition effect. IFDI inflow will inevitably aggravate the competition in the host country's market [25], reducing the operating profits of disadvantaged domestic companies and downsizing production scale, weakening the ability and enthusiasm of green technology innovation, and even forcing small and medium-sized enterprises to withdraw from operations. In this case, it will not be conductive to enhancement the green development quality of the logistics industry. Thirdly, IFDI has a "pollution paradise". To attract foreign-funded enterprises to settle down, Chinese local governments have substantially lowered the entry threshold of IFDI. Therefore, it is not bound to bring in advanced technologies with the introduction of IFDI, which will intensify the environmental pollution and resource consumption of the host country due to its scale effect [26]. Foreign-funded enterprises impelled by profits not necessarily prefer green technological innovation.

On the other hand, IFDI facilitates the improvement of green development quality of the logistics industry. First, due to the crowding-in effect of IFDI on domestic investment, IFDI inflow can help expand the total domestic capital stock of the industry [27]. In the early development of China's logistics industry, to cope with the contradiction between "capital shortage" and "large-scale investment", foreign enterprises served as the new fund source for the development of the logistics industry, alleviating this contradiction to a certain extent. This can help logistics industry to get rid of the "vicious circle of backwardness", thereby promoting capital formation in China's logistics industry and addressing insufficient funding issues for green innovation to a certain extent. Secondly, IFDI has a technology spillover effect through demonstration-imitation effect, market competition effect, and personnel training effect [28]. Foreign-funded enterprises transfer and diffuse environmentally friendly technologies to local companies, thereby improving energy efficiency and contributing to environmental quality enhancement in the host country [29, 30]. Thirdly, FDI has a "pollution halo" effect. As foreign-funded enterprises generally execute strict environmental standards, IFDI inflow is conductive to reducing pollution [31]. Furthermore, IFDI has been proven to improve the income level of the host country. The higher income level, the stronger residents' environmental awareness. So, it is conductive to the improvement of environmental quality. The mechanism of IFDI's effect on the green development quality of the logistics industry is shown in Fig. 1. Based on the above analysis, this paper proposes research hypothesis 1:

H_1: IFDI influences the green development quality of the logistics industry.

H_{1a}: IFDI promotes the improvement of green development quality of the logistics industry;

H_{1b}: IFDI inhibits the improvement of green development quality of the logistics industry.

OFDI and the Green Development Quality

OFDI has a promoting and inhibiting effect on the green development quality of the logistics industry. On one hand, OFDI inhibits the improvement of the green development quality of the logistics industry. First, OFDI has a "hollow effect", which means outward foreign direct investment by enterprises in any form will lead to capital cross-border outflow [32]. This will squeeze out enterprise R&D investment to a certain degree, thus impeding the technological progress of enterprises and further inhibiting the improvement of the green development quality. If the capital cross-border drain cannot be supplemented timely from other financing channels, "capital shortage" will incur and hinder the expansion and further development of the industry [33]. Secondly, the "going out" is mainly adopted by large and medium-sized state-owned enterprises in China's logistics industry, which conduct outward foreign direct investment not for chasing profits but for strategic resource guarantee. Such OFDI may have weak reverse green technology spillover effect. Moreover, OFDI will have a negative influence on enterprise business performance, thereby inhibiting quality improvement of green development. Thirdly, OFDI has a scale effect. Since the profit return mechanism of OFDI is conductive to expanding the operating scale of the parent company and the scale of the domestic logistics market, there will be more pollutant discharge [34].

On the other hand, OFDI accelerate the quality improvement of logistics green development. Firstly, OFDI has a profit return mechanism. By transferring the profits obtained in the overseas market back to the parent company, company can offer more funds for the parent company's green technology research and development. Secondly, OFDI has the reverse green technology spillover effect. Multinational corporations can obtain reverse green technology spillovers in two ways: (1) Multinational corporations can establish technology R&D departments in the host country and feedback new technologies to the parent company [35]. (2) Overseas subsidiaries obtain green technologies through interaction with stakeholders (suppliers, customers, governments and non-profit organization in the host country). Through internal interactions between subsidiaries and parent companies, such as internal labor mobility and experience sharing, new technologies and new knowledge are spilled to the parent company and the home country [36, 37]. Thirdly, OFDI has a market competition effect. Enterprises are faced up with various challenges when entering overseas markets. They also need to cope with competitors in the same industry in the host country. In response to fierce market competition and the complex and changeable international environment, enterprises have to make technological innovations to improve resource allocation. Such competition after spreading to the home country market will urge local enterprises to make efforts to improve their technological level. The mechanism of OFDI's effect on the green development quality of the logistics industry is shown in Fig. 2. Based on the above analysis, this paper proposes research hypothesis 2:

H_2: OFDI influences the green development quality of the logistics industry.

H_{2a}: OFDI promotes the improvement of green development quality of the logistics industry;

H_{2b}: OFDI inhibits the improvement of green development quality of the logistics industry.

Two-Way FDI, Environmental Regulations and the Green Development Quality

Environmental regulations play a key role in IFDI quality screening. It is common for a country or region to adopt measures to reduce the environmental regulation intensity so as to attract more IFDI flows. However, low-intensity environmental regulations and standards will result in the occurrence of "pollution haven", and hinder the growth of green economy in the long run [38]. Stringent environmental regulations can attract clean IFDI from developed economies and facilitate green technology spillover [39]. However, excessive environmental regulation can enhance

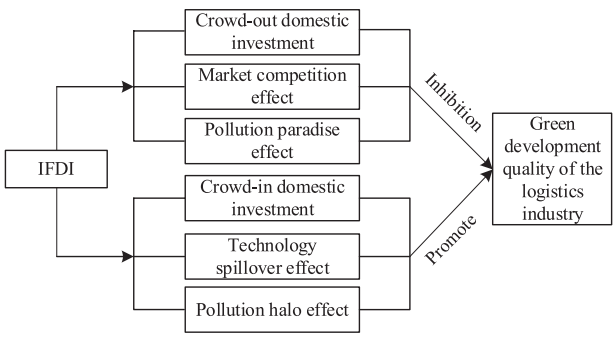

Fig. 1. The internal mechanism of IFDI affecting the green development quality of the logistics industry.

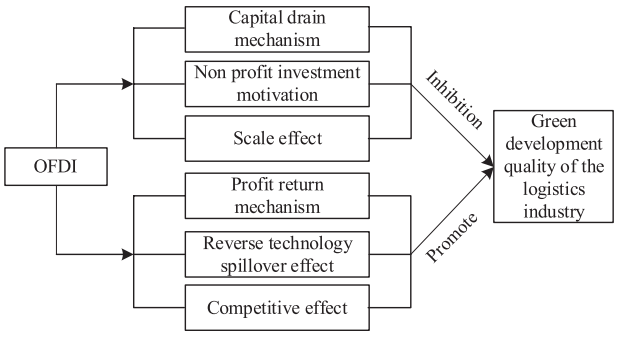

Fig. 2. The internal mechanism of OFDI affecting the green development quality of the logistics industry.

the inhibiting effect of FDI on green technology innovation [40]. Only reasonable and formal environmental regulations can encourage enterprises to conduct more green technological innovations, thereby enhancing product quality. When green products receive widespread popularity in the market, environmental regulations can create a "compensation effect of science and technology innovation" [41].

When the host country implements strict environmental regulations, overseas subsidiaries will raise environmental standards in the process of providing services to meet the requirements of the host country. However, if the environmental regulations intensity in the home country is not strong enough, the costs of applying environmentally advanced technology acquired abroad to business operations cannot be offset by benefits from clean production and green products, weakening the willingness of home country companies to undertake environmental practice [42]. When the host country does not implement strict environmental regulations, but the home country implements strict environmental regulations, the enterprise prefers to look for ecological technologies in the process of OFDI [43], and then transfer the ecological technology back to the home country, which is conducive to improving the green development quality of the logistics industry. The mechanism of environmental regulation regulates the relationship between two-way FDI and green development quality of the logistics industry is shown in Fig. 3. Based on the above analysis, this paper proposes research hypothesis 3:

H3: Affected by environmental regulations, two-way FDI has a threshold effect on the green development quality of the logistics industry.

To sum up, the existing literature has carried out a lot of exploration on the relationship between environmental regulation, two-way FDI and economic green development, but there are still some areas that need to be deepened and expanded. Firstly, most of the existing literature use a single index such as GTFP or logistics performance to measure the green development level of the logistics industry. However, the green development quality is a comprehensive evaluation of the green development of the logistics industry, and cannot be measured only by a single index. Secondly, few literature examine the relationship between two-way FDI and green development from the perspective of the logistics industry. Research from a macro perspective often ignores industry heterogeneity, making research conclusions and policy recommendations not necessarily applicable to specific industries. Finally, existing research focuses on the one-way impact of IFDI on the economic development of the host country or the one-way impact of OFDI on the economic development of the home country. However, IFDI and OFDI have become the realistic characteristics of the logistics industry, and there is a problem of taking a part of the whole in a segmented study of IFDI or OFDI.

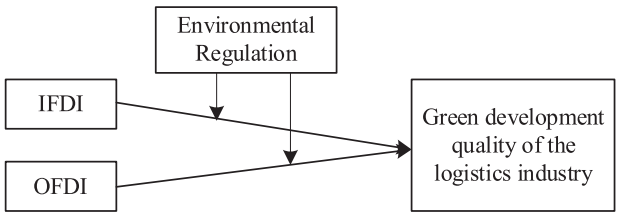

Fig. 3. The mechanism of environmental regulation regulates the relationship between two-way FDI and green development quality of the logistics industry.

Compared to the existing studies, the marginal contribution of this paper are as follows. Firstly, this paper establishes an evaluation index system for the green development quality of the logistics industry, then applies the entropy weight method to measure the green development quality of the logistics industry in different regions. Secondly, this paper expands the study of the relationship between two-way FDI and green development quality of the logistics industry. Specifically, this paper uses the China's inter-provincial panel data to investigate the overall effect, spatio-temporal heterogeneity effect and threshold effect of two-way FDI on the green development quality of the logistics industry. Thirdly, in view of the fact that the logistics industry utilizes foreign investment and invest overseas simultaneously, this paper breaks through the limitation of one-way analysis, takes the two-way symbiosis of IFDI and OFDI as the perspective, and incorporates IFDI, OFDI and the interaction items of two-way FDI in the logistics industry into the research framework at the same time.

Material and Methods

Model Setting

In order to investigate the impact of two-way FDI on the green development quality of the logistics industry, the following basic panel model is constructed:

$$\ln GDQ_{it} = \alpha_0 + \alpha_1 \ln IFDI_{it} + \alpha_2 \ln OFDI_{it} + \alpha Z_{it} + \mu_i + \upsilon_t + \varepsilon_{it} \quad (1)$$

Where i is the province; the year is expressed by t; GDQ represents the green development quality of the logistics industry; Z represent the control variables; μ_i and υ_t denote individual effect and time effect, respectively; ε is the random disturbance item.

By introducing environmental regulation intensity into the basic panel model of two-way FDI influencing the green development quality of the logistics industry as a threshold variable, a panel threshold model is constructed. Threshold effect means that if the explanatory variable reaches a certain threshold, its influence on the explained variable will change.

The panel threshold model can accurately reveal the nonlinear relationship between explanatory variables and explained variables [40]. Based on the threshold model constructed by Hansen [44], this paper constructs the following panel threshold model:

$$\ln GDQ_{it} = \alpha_0 + \alpha_1 \ln IFDI_{it} \cdot I(q_{it} \le \gamma_1) + \alpha_2 \ln IFDI_{it} \cdot I(\gamma_1 < q_{it} \le \gamma_2) + ... + \alpha_{2n-1} \ln IFDI_{it} \cdot I(q_{it} > \gamma_n) + \beta \ln OFDI_{it} + \psi Z_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

$$\ln GDQ_{it} = \beta_0 + \beta_1 \ln OFDI_{it} \cdot I(q_{it} \le \gamma_1) + \beta_2 \ln OFDI_{it} \cdot I(\gamma_1 < q_{it} \le \gamma_2) + ... + \beta_{2n-1} \ln OFDI_{it} \cdot I(q_{it} > \gamma_n) + \alpha \ln IFDI_{it} + \psi Z_{it} + \mu_i + \varepsilon_{it} \quad (3)$$

Where q_{it} is the threshold variable, that is, the environmental regulation intensity. γ represent the threshold value; $I(\cdot)$ is the indicator function. If the conditions in the brackets are established, $I = 1$, otherwise, $I = 0$.

Variable Selection and Description

Explained Variable

According to the above definition of the green development quality of the logistics industry, a logistics industry green development quality evaluation index system is established, which includes 7 indicators in three dimensions: operation scale, production efficiency and energy conservation and emission reduction. Specifically, the operation scale reflects the economic growth of the logistics industry, the production efficiency reflects the use of resources by the logistics industry, and energy conservation and emission reduction indicate the impact of logistics activities on the environment. The green development quality evaluation index system of the logistics industry is shown in Table 1. On the basis of constructing an index system, the entropy weight method is used to measure the green development quality of the logistics industry.

As an objective weighting method, entropy weight method can avoid the bias caused by subjective factors and adequately consider the information of values all the units, which can weaken the bad effect from some abnormal values and make the result of evaluation more accurate and reasonable [45]. The basic steps of the entropy weight method are as follows:

Step 1. Standardize the original value.

Positive indicator: $$x_{ij}^* = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (4)$$

Inverse indicator: $$x_{ij}^* = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})} \quad (5)$$

where x_{ij} represents the original value of province ($j = 1, 2, ..., m$) with indicator ($j = 1, 2, ..., n$) .

Step 2. Calculate the contribution degree of each standardized value.

$$p_{ij} = \frac{x_{ij}^*}{\sum_{i=1}^{m} x_{ij}^*} \quad (6)$$

Step 3. Calculate the entropy e_j and variation coefficient d_j of each indicator.

$$e_j = -\left[\ln(m)\right]^{-1} \sum_{i=1}^{m} p_{ij} \ln p_{ij} \quad (7)$$

$$d_j = 1 - e_j \quad (8)$$

If the ratio value $p_{ij}^t = 0$ then

$$\lim_{p_{ij}^t \to 0} p_{ij}^t \times \ln\left(p_{ij}^t\right) = 0 \quad (9)$$

Step 4. Calculate the weight of each indicator.

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad (10)$$

Table 1. The green development quality evaluation index system of the logistics industry.

Dimension index	Basic indicators	Calculate	Attributes
Operation scale	Per capita added value of the logistics industry	Added value of the logistics industry / total population	+
	Contribution of the logistics industry	Added value of the logistics industry / GDP	+
Production efficiency	Labor productivity	Added value of the logistics industry / number of employees	+
	Capital productivity	Added value of the logistics industry / investment in fixed assets	+
	Land productivity	Added value of the logistics industry / length of traffic line	+
Energy conservation and emission reduction	Energy consumption per unit value added	Energy consumption / value added of the logistics industry	–
	Carbon emissions per unit value added	Carbon emissions / value added of the logistics industry	–

Step 5. Calculate the green development quality of the logistics industry.

$$GDQ_i = \sum_{j=1}^{n} w_i x_{ij}^* \tag{11}$$

Core Explanatory Variable

Two-way FDI refers to the long-term connection between foreign capital and domestic production, so, it is not feasible to use the current flow to measure the impact of IFDI (OFDI) on the economy of the host (home) country. Therefore, two-way FDI flow is transformed into two-way FDI stock variable in order to account for the longer-term effect of two-way FDI on the green development quality of the logistics industry. By referring to what Sapkota and Bastola [46] has conducted, this paper uses formula (12) and formula (13) to calculate the stock of two-way FDI of the logistics industry.

$$IFDI_{it} = (1-\delta)IFDI_{it-1} + IFDI_{it}^{f} / p_{it} \tag{12}$$

$$OFDI_{it} = (1-\delta)OFDI_{it-1} + OFDI_{it}^{f} / p_{it} \tag{13}$$

Where $IFDI^f$ and $OFDI^f$ represent IFDI flow and OFDI flow, respectively; the investment price index is expressed by p; the depreciation rate is expressed by δ, which is valued as 9.6% [47]. With 2006 as the base period, the two-way FDI flow will be deflated.

Interaction Term

To investigate whether the interactive development of two-way FDI will benefit green development of the logistics industry, the interactive item of two-way FDI is introduced into the model, and decentralization of interactive item is performed [48].

Threshold Variable

Environmental pollution control investment as a percentage of GDP has been selected to measure environmental regulation intensity. The greater the investment in environmental pollution control, the greater the intensity of environmental supervision.

Control Variables

Digitization level. Digital transformation is a driving force for innovative, inclusive, and sustainable growth [49]. In this paper, internet penetration rate, mobile phone penetration rate, per capita telecommunication service volume, the proportion of computer service and software industry employees in urban employees are selected for fitting into one indicator to represent the level of digitalization through factor analysis method.

Agglomeration level of the logistics industry. The externality effects of industrial agglomeration, such as knowledge and technology spillovers, scale economies effect, and imitative innovation effects, are key routes to realize industrial green development. In this paper, location entropy indexes are adopted to measure the level of agglomeration of the logistics industry [50].

Human capital level. A high level of human capital is the premise of introducing, absorbing and innovating advanced green technologies and applying advanced management methods. In this paper, the average years of education in different areas are used to measure the human capital level. The formula is:

$$HUM = \frac{\text{primary school}*6 + \text{junior high school}*9 + \text{high school}*12 + \text{college}*15 + \text{university}*16 + \text{postgraduate and above}*19}{\text{the total population after the age of 6}} \tag{14}$$

Innovation capability. Technological innovation, in particular green technologies, can reduce pollution emissions and promote green economic development [51]. Patents are a concrete representation of innovation competitiveness [51]. Considering that there is a certain time lag in patent authorization, the number of patent applications in the logistics industry per 10,000 people is used to measure the ability of independent innovation.

Data Sources

In China, the logistics industry is not included in the Industrial Classification For National Economic Activities system. The practice of referring to most literature is replaced by data on transportation, warehousing and postal services [52]. In order to expand the number of samples as much as possible, 2006 was selected as the starting time, while excluding the seven provinces (Jilin, Qinghai, Ningxia, Tibet, Hong Kong, Macao and Taiwan) that lack data. The relevant data of OFDI in the logistics industry are mainly from the Directory of Overseas Investment Enterprises (Institutions), but the Directory of Overseas Investment Enterprises (Institutions) only counts the enterprise data from 1983 to 2015. Therefore, this paper uses the data of 27 provinces in China from 2006 to 2015 for empirical analysis. The data are mainly derived from the Directory of Overseas Investment Enterprises (Institutions), report on Foreign Investment in China, Statistical Bulletin of China's Outward Foreign Direct Investment, China Statistical Yearbook, China Labor Statistics Yearbook, China Statistics Yearbook on Environment, China Energy Statistical Yearbook and statistical yearbooks of local areas. In order to eliminate the impact of price fluctuations, price-related variables are converted to actual values based on 2006. To minimize heteroscedasticity and reduce data fluctuations, logarithmic processing of all

Table 2. Descriptive statistics of variables.

Variable type	Variable name	Symbol	Min	Max	Average	Std	VIF
Explained variable	Green development quality of the logistics industry	ln *GDQ*	-4.011	-0.220	-1.395	0.640	—
Explanatory variables	IFDI stock of the logistics	ln *IFDI*	5.419	14.320	11.900	1.741	2.50
	OFDI stock of the logistics	ln *OFDI*	4.502	13.722	11.130	1.787	2.75
Interactive item	Two-way FDI interactive items	ln *TIDL*	-2.636	30.319	1.982	3.947	1.53
Control variables	Digitization level	*DIGE*	-0.976	2.405	0.022	0.828	2.14
	Agglomeration level	ln *AGG*	-0.611	0.610	-0.017	0.252	1.76
	Human capital level	ln *HUM*	1.901	2.648	2.287	0.136	5.39
	Innovation Capability	ln *INNO*	-3.577	1.796	-1.194	1.235	3.50
Threshold variable	Environmental regulation intensity	ln *ER*	-0.916	1.445	0.195	0.435	—

variables except the digitization level is performed. The descriptive statistics of all variables are shown in Table 2.

Results and Discussion

Stationarity Test

To avoid spurious regressions, it is necessary to test the stationarity of macro-variables before estimations. According to the results in Table 3, most of the variables have passed the unit root tests so it can be judged that all the variables can be used for the following analysis.

Estimation Results and Analysis of Basic Panel Model

In this paper, ordinary least squares (OLS), fixed effect model (FE) and random effect model (RE) are used to regress formula (1) and determine which model is the most appropriate. According to the regression results, the F statistic is 46.40 and the p value is 0.000, indicating that FE is significantly better than OLS; The p value of Hausman test is 0.017<0.05, indicating that the fixed effect model should be used. The benchmark regression results are shown in Table 4.

As shown in column (6), two-way FDI has significantly enhanced the green development quality of the logistics industry, verifying the research hypotheses H_{1a} and H_{2a}. IFDI plays a greater role in promoting the green development quality than OFDI. Specifically, the influence of IFDI on the green development quality of the logistics industry is significantly positive. Khan and Dong [53], Guo et al. [54] used the data of the whole industry's IFDI to test the impact of IFDI on the performance of green logistics, and found that there is a positive correlation between the two, which is consistent with the research results obtained in this paper using the data of the logistics industry's IFDI. However, Barut et al. [17] found that IFDI reduce the green logistics performance in developing emerging seven countries, due to weak environmental laws in these developing countries. This shows that environmental regulation may play a role in the relationship between IFDI and the green development quality of the logistics industry.

Table 3. Panel unit root test results.

Variables	LLC test	AD-Fisher test	PP-Fisher test	HT test	Hadri LM test
ln *GDQ*	-7.4093***	179.0667***	120.3107***	0.5149***	12.0631***
ln *IFDI*	-6.4937***	107.9255***	55.3400	0.5675***	6.7295***
ln *OFDI*	-22.6269***	416.6476***	308.9353***	0.4295***	10.0482***
ln *TIDL*	-18.2042***	219.2474***	213.6221***	0.7226	19.4479***
DIGE	-33.1272***	289.3061***	86.1602***	0.6167**	15.4869***
ln *AGG*	-4.3357***	50.7716	52.6776	0.6342**	13.3194***
ln *HUM*	-5.9674***	56.4869	56.1994	0.6875	17.0337***
ln *INNO*	-4.2941***	73.0099**	95.1410***	0.7272	17.4862***

Note: *, **, *** denote 10%, 5%, 1% levels of significance, respectively.

Table 4. Regression results of total samples.

Variables	OLS	RE	FE			
	(1)	(2)	(3)	(4)	(5)	(6)
ln *IFDI*	0.069** (2.27)	0.083* (1.76)	0.150** (2.07)		0.080** (2.11)	0.102** (2.40)
ln *OFDI*	0.043** (2.50)	0.092*** (4.00)		0.045** (2.14)	0.099*** (4.14)	0.094*** (3.95)
ln *TIDL*	0.056*** (7.59)	0.032*** (5.04)			0.026*** (4.45)	0.030*** (4.63)
DIGE	-0.278*** (-5.44)	0.114* (1.70)	0.127* (1.73)	0.126* (1.72)		0.153** (2.05)
ln *AGG*	-0.311* (-1.79)	-0.351** (-2.29)	-0.505*** (-2.88)	-0.435** (-2.54)		-0.443*** (-2.65)
ln *HUM*	3.392*** (5.53)	0.725 (1.62)	-0.196 (-0.47)	-0.404 (-0.92)		0.513 (1.09)
ln *INNO*	0.121** (2.12)	0.001 (0.02)	0.040 (0.60)	0.043 (0.65)		0.013** (2.20)
Cons	-9.825*** (-7.26)	-4.827*** (-4.24)	-2.622** (-2.22)	-0.820 (-0.85)	-3.241*** (-3.95)	-4.624*** (-3.58)
Years	Control	Control	Control	Control	Control	Control
Provinces	No Control	No Control	Control	Control	Control	Control

Note: *, **, *** denote 10%, 5%, 1% levels of significance, respectively. t or z values are shown in parentheses.

IFDI will generate a series of effects upon its entry into the host country. The most direct manifestation is that due to the continuous inflow of foreign capital, the funding gap required for the development of the logistics industry can be effectively remedied, thereby benefiting enterprises to expand the scale and develop green technologies. In addition, multinational corporations after entering Chinese logistics market can introduce more advanced equipment, technology, talents and management experience, effectively remedying the technological gap required for the development of the logistics industry. The influence of OFDI on the green development quality of the logistics industry is significantly positive and conforms to the result of Ali et al. [55]. The research results of Ali et al. [55] show that OFDI in the logistics industry is an important reason for the improvement of the production efficiency of the logistics industry. OFDI can help provide more funding sources for the green technology research and development of the parent company by returning profits. Furthermore, it can also stimulate the parent company to strengthen R&D and innovation investment, thereby facilitating the green technology development in the home country. Moreover, due to the reverse green technology spillover effect of OFDI, the green technology level and the green productivity of the logistics industry can be directly enhanced.

The estimated coefficient of the two-way FDI interaction item ln *TIDL* is significantly positive at the 1% level, indicating a complementary effect between two-way FDI of the logistics industry, and IFDI (OFDI) up-regulation have a positive influence of OFDI (IFDI) on the green development quality of the logistics industry. The coefficient of estimation of digitalization level is 0.153 which is significant at the level of 5%. Peng et al. [56] confirmed that digital technologies such as the Internet are the core drivers of logistics green competitiveness. Digital technologies reduce the energy consumption of freight logistics activities, and promote the healthy development of logistics industry. For every 1% increase in the level of industrial agglomeration, the green development quality of the logistics industry will decrease by 0.443%, indicating that industrial agglomeration has a significant negative impact on the green development of the logistics industry. This may be because the "crowding effect" of industrial agglomeration exceeds the "scale effect", which is not conducive to the green development of the logistics industry [19]. The coefficient of estimation of human capital level is not significantly positive, suggesting that human capital level is not conductive to the green development of the logistics industry. Perhaps because green growth requires a higher quality of human capital supply [18]. Vandenbussche et al. [57] held that only manpower receiving higher education can facilitate productivity improvement. The estimated coefficient of innovation capability is significantly positive at the 5% level, which supports the result of Guo et al. [54]. New technologies and new products are applied to the logistics industry, and outdated and inefficient technologies and equipment are eliminated, which is conducive to improving the service efficiency of the

logistics industry and reducing unnecessary energy consumption.

Heterogeneity Analysis

The two-way FDI and green development quality of the logistics industry have obvious spatial and temporal heterogeneity. Therefore, this paper divides the total sample into eastern, central and western regions, and divides the sample period into 2006-2010 and 2011-2015. The regression results are shown in Table 5.

There are obvious regional differences in the impact of two-way FDI on the green development quality of the logistics industry. In the eastern region, two-way FDI has significantly improved the green development quality of the logistics industry. In the central region, only IFDI can improve the green development quality of the logistics industry, and the estimated coefficient of OFDI is positive but not significant. In the western region, two-way FDI has not had a significant positive impact on the green development quality of the logistics industry. Luo et al. [58] used the whole industry's two-way FDI data to examine the impact of two-way FDI on the quality of China's economic growth. The results show that only in the eastern region, two-way FDI significantly improves the quality of economic growth. Pan et al. [35] also found that the reverse technology spillover effect of China's OFDI only has a positive impact on carbon productivity in the eastern region. The eastern region has attracted large-scale and high-level foreign investment in the logistics industry by virtue of its superior geographical location, strong industrial foundation and preferential policies. It can accelerate the green development of the local logistics industry by absorbing the funds, information, technology and experience transferred by foreign investment. At the same time, the eastern region is the earliest area where the logistics industry "going out", and the scale of OFDI is relatively large, so it has a greater impact on the green development quality of the logistics industry. In the period from 2006 to 2010, the estimated coefficients of IFDI was 0.113 passed the significance level test of at 10%. In the period from 2011 to 2015, the estimated coefficient value of IFDI dropped to 0.015, but also passed the significance level test of at 5%. Adnan et al. [59] used Pakistan as a research subject and found that IFDI had a positive effect on TFP in both the short and long term. In the period from 2006 to 2010, the estimated coefficients of OFDI was 0.047, but it was not significant. In the period from 2011 to 2015, the estimated coefficient of OFDI rose to 0.203 and passed the significance level test of at 5%. This also shows that the promotion effect of IFDI on the green development quality of the logistics industry has been weakened as time goes on, while the promotion effect of OFDI on the green development quality of the logistics industry has been enhanced as time goes on.

Estimation Results and Analysis of Panel Threshold Model

Before estimating the parameters of the panel threshold model, the threshold number and threshold value of the threshold variables should be determined so as to determine the specific form of the threshold model. As shown in Table 6, with the environmental regulations intensity as the threshold variable, the impact of IFDI on the green development quality of the logistics industry has a double threshold effect, with threshold values of -0.2485 and 0.3436 respectively. The impact of OFDI on the green development quality of the logistics industry has a single threshold effect, and the threshold is 0.1222.

The results for the threshold effect test are represented in Table 6. When the environmental regulations intensity is lower than -0.2485, the influence of IFDI on

Table 5. Regression results of different samples.

Variables	Different regions			Different periods	
	Eastern	Central	Western	2006-2010	2011-2015
ln *IFDI*	0.040** (2.34)	0.151** (2.22)	-0.144 (-0.96)	0.113* (1.75)	0.015** (2.19)
ln *OFDI*	0.015** (2.36)	0.056 (1.50)	0.055 (1.08)	0.047 (1.59)	0.203** (2.33)
ln *TIDL*	0.036*** (2.77)	0.103*** (3.63)	0.018 (1.34)	0.018* (1.72)	0.097** (2.30)
Other variables	Control	Control	Control	Control	Control
Cons	-1.259 (-0.80)	-7.616*** (-3.49)	3.912 (1.11)	-2.675 (-1.01)	-3.095 (-1.33)
Years	Control	Control	Control	Control	Control
Provinces	Control	Control	Control	Control	Control

Note: *, **, *** denote 10%, 5%, 1% levels of significance, respectively. t values are shown in parentheses.

Table 6. Estimation results of threshold effect of environmental regulation.

Estimation results of threshold							
Variables	Threshold type	Threshold value	F value	P value	10%	5%	1%
IFDI	Single threshold	-0.2485	19.23**	0.0333	15.9598	18.3569	22.9950
	Double threshold	0.3436	16.05*	0.0667	14.8742	16.8941	21.2559
	Triple threshold	0.5068	2.77	0.8567	10.1116	12.2723	17.7691
OFDI	Single threshold	0.1222	14.08**	0.0467	12.1137	13.9906	15.8392
	Double threshold	0.5068	8.20	0.1200	8.5123	11.0521	14.5534

Parameter estimation results of threshold model			
Variables	Estimated coefficient	t value	P value
ln *IFDI* (ln *ER*≤-0.2485)	0.056	0.34	0.736
ln *IFDI* (-0.2485<ln *ER*≤0.3436)	0.087**	2.48	0.014
ln *IFDI* (ln *ER*>0.3436)	0.054**	2.14	0.033
Other variables	Control		
ln *OFDI* (ln *ER*≤0.1222)	0.046**	2.23	0.029
ln *OFDI* (ln *ER*>0.1222)	0.071***	2.81	0.006
Other variables	Control		

Note: *, **, *** denote 10%, 5%, 1% levels of significance, respectively.

the green development quality of the logistics industry is not significantly negative. Only when exceeding -0.2485 will it leverage IFDI positive influence on the green development quality of the logistics industry. With the improvement of environmental regulations intensity, that is, exceeding 0.3436, the promoting effect of IFDI on the green development quality will be greatly weakened, the coefficient of estimation decreases from 0.087 to 0.054. This also means that when the current environmental regulation intensity is between -0.2485 and 0.3436, IFDI has the greatest effect on promoting the green development quality of the logistics industry. In other words, local governments should control the environmental regulations intensity within a certain range. This is similar to the findings of Wang and Liu [60]. Specifically, the research results of Wang and Liu [60] showed that when the environmental regulation is between the first threshold and the second threshold, IFDI is more conducive to the reduction of environmental pollution levels in China.

OFDI has passed the single threshold test at the level of 5%, which supports the result of Zhou et al. [42]. When the environmental regulations intensity is lower than 0.1222, the influence of OFDI on the green development quality of the logistics industry is significantly positive, and the estimated coefficient of OFDI is 0.046. With the environmental regulations intensity further increases, that is, when crossing the threshold of 0.1222, the influence of OFDI on the green development quality would increase from 0.046 to 0.071, and can pass the 1% significance level test. This means that OFDI can transfer green technology spillover back to the home country using the moderating effect of environmental regulation [43].

According to the estimated results in Table 6, we divide the environmental regulations intensity into four intervals: ln *ER*≤-0.2485, -0.2485<ln *ER*≤0.1222, 0.1222<ln *ER*≤0.3436, ln *ER*>0.3436. Table 7 shows the range of environmental regulation intensity in China's 27 provinces in 2015. It can be seen from Table 7 that

Table 7. Environmental regulation intensity of each province in 2015.

Environmental regulation intensity	Provinces
ln *ER*≤-0.2485	Tianjin, Guangdong, Hainan, Sichuan
-0.2485<ln *ER*≤0.1222	Liaoning, Heilongjiang, Shanghai, Zhejiang, Fujian, Shandong, Henan, Hubei, Chongqing, Yunnan
0.1222<ln *ER*≤0.3436	Hebei, Jiangsu, Jiangxi, Guizhou, Shaanxi
ln *ER*>0.3436	Beijing, Shanxi, Inner Mongolia, Anhui, Hunan, Guangxi, Gansu, Xinjiang

in 2015, only five provinces including Hebei, Jiangsu, Jiangxi, Guizhou and Shaanxi had environmental regulations intensity is between 0.1222 and 0.3436. The positive impact of IFDI and OFDI on the green development quality of the logistics industry can be fully released at the same time. The environmental regulation intensity in Tianjin, Guangdong, Hainan and Sichuan is less than -0.2485, which can not make IFDI play a role in promoting the green development quality of the logistics industry.

Conclusions and Policy Implications

Conclusions

This article empirically tests the impact of two-way FDI on the green development quality of the logistics industry based on the panel data of 27 provinces in China from 2006 to 2015. This paper mainly draws following research conclusions: (1) Two-way FDI and its interactive items can significantly facilitate the green development of the logistics industry, and IFDI plays a stronger promoting role than OFDI. (2) Only in the eastern region, IFDI and OFDI have played a significant role in promoting the green development of the logistics industry at the same time. (3) The role of IFDI in improving the green development quality of the logistics industry has weakened over time, while OFDI has strengthened. (4) Taking environmental regulations intensity as the threshold variable, IFDI and OFDI has a double threshold effect and a single threshold effect on the green development quality of the logistics industry, respectively. When the environmental regulations intensity crossing the threshold value of -0.2485, the influence of IFDI on the green development quality changes from insignificantly positive to significantly positive. When the environmental regulations intensity crossing the threshold value of 0.1222, OFDI plays a greater role in promoting the green development quality of the logistics industry.

Policy Implications

Based on the above conclusions, some feasible policy recommendations to further improve the green development quality of the logistics industry in China are proposed.

Firstly, two-way FDI has significantly improved the green development quality of the logistics industry. This finding indicates that China's logistics industry needs to adhere to both "bringing in" and "going out" strategies. On the one hand, on the premise of not jeopardizing national security and major national interests, China needs to continue to liberalize foreign investment access and shareholding restrictions in logistics-related fields such as trade logistics, express delivery, and warehousing facilities. In this way, China can learn from foreign experience, practices and advanced concepts in promoting the development of the logistics industry. Furthermore, local governments should formulate scientific and reasonable investment attraction policies, introduce high-level high-quality foreign capital, pay attention to the environmental benefits of the inflow of IFDI, and release the green technology spillover effect of IFDI. On the other hand, the government should deliver dynamics information on domestic and international economic policies regularly, reinforce the macro-guidance of overseas investment, assist logistics enterprises in risk identification and investment estimation, and improve the success rate of outbound investment. At the same time enterprises should take the initiative to learn from advanced green technologies of the host country, and improve the green economy efficacy of the home country through digest, absorption and innovation of green technologies.

Secondly, there is obvious regional heterogeneity in the impact of two-way FDI on the green development quality of the logistics industry. This finding indicates that local governments need to take targeted measures in light of their own realities. Specifically, the eastern region should introduce high-quality foreign investment in the logistics industry, focusing on the technical level, management level and profitability of IFDI. For the central region, the impact of OFDI on the green development quality of the logistics industry is not significant. Therefore, local governments should strengthen the guidance and assistance for logistics enterprises to "going out", and provide financial, legal aid, information services and other support. For the western region, the impact of two-way FDI on the green development quality of the logistics industry is not significant. Therefore, the western region should take advantage of the opportunity of the "Belt and Road" initiative to attract foreign capital in the logistics industry by virtue of its advantages in natural resources and labor costs, promote the development of local logistics industry by means of foreign capital, and improve the strength and willingness of local logistics enterprises to "going out" by relying on the capital and technology obtained by foreign capital.

Thirdly, the impact of two-way FDI on the green development quality of the logistics industry has a threshold effect based on environmental regulation. This finding suggests that the government should improve environmental supervision. On the one hand, we should improve the implementation of environmental supervision, limit foreign-funded projects with low level, high consumption and high pollution, and encourage the introduction of environmentally-friendly foreign-funded enterprises. On the other hand, the government should help "going out" companies to establish green development concepts, and force companies to seek ecological technologies through the strong environmental regulations of the home country. It is worth noting that the government should not blindly improve the environmental regulation intensity, but

should control the environmental regulations intensity within a reasonable range.

Acknowledgments

This study was supported by the Scientific Research Projects of Introduced Talents at Fujian Jiangxia University (grant No. 00141125) and by the Social Science Planning Project of Fujian Province, China (grant No. FJ2020C014).

Conflict of Interest

The authors declare no conflict of interest.

References

1. MUKHTAROV S., YUKSEL S., DINCER H. The impact of financial development on renewable energy consumption: Evidence from Turkey. Renewable Energy, **187**, 169, **2022**.
2. WEHNER J., DEILAMI N.T.N., VURAL C.A., HALLDORSSON A. Logistics service providers' energy efficiency initiatives for environmental sustainability. International Journal of Logistics Management, **33** (5), 1, **2021**.
3. MOHSIN A.K.M., TUSHAR H., HOSSAIN S.F.A., CHISTY K.K.S., IQBAL M.M., KAMRUZZAMAN M., RAHMAN S. Green logistics and environment, economic growth in the context of the Belt and Road Initiative. Heliyon, **8** (6), e09641, **2022**.
4. VIENAZINDIENE M., TAMULIENE V., ZALECKIEN J. Green Logistics Practices Seeking Development of Sustainability: Evidence from Lithuanian Transportation and Logistics Companies. Energies, **14** (22), 7500, **2021**.
5. LI M., WANG J. Spatial-temporal distribution characteristics and driving mechanism of green total factor productivity in China's Logistics Industry. Polish Journal of Environmental Studies, **30** (1), 201, **2021**.
6. AGYABENG-MENSAH Y., TANG L. The relationship among green human capital, green logistics practices, green competitiveness, social performance and financial performance. Journal of Manufacturing Technology Management, **32** (7), 1377, **2021**.
7. WANG K., UMAR M., AKRAM R., CAGLAR E. Is technological innovation making world "Greener"? An evidence from changing growth story of China. Technological Forecasting and Social Change, **165**, 120516, **2021**.
8. HAO Y., BA N., REN S., WU H. How does international technology spillover affect China's carbon emissions? A new perspective through intellectual property protection. Sustainable Production and Consumption, **25**, 577, **2021**.
9. ZAMANI Z., TAYEBI S.K. Spillover effects of trade and foreign direct investment on economic growth: An implication for sustainable development. Environment Development and Sustainability, **24 (3)**, 3967, **2022**.
10. LUO Y., SALMAN M., LU Z. Heterogeneous impacts of environmental regulations and foreign direct investment on green innovation across different regions in China. Science of The Total Environment, **759** (2), 143744, **2021**.
11. TRIPATHY P., KHATUA M., BEHERA P., SATPATHYY L.D., JENA P.K., MISHRA B.R. Dynamic link between bilateral FDI, the quality of environment and institutions: Evidence from G20 countries. Environmental Science and Pollution Research, **29** (18), 27150, **2022**.
12. KASZTELAN A. Green growth, green economy and sustainable development: terminological and relational discourse. Prague Economic Papers, **26** (4), 487, **2017**.
13. AGYABENG-MENSAH Y., AFUM E., AHENKORAH E. Exploring financial performance and green logistics management practices: Examining the mediating influences of market, environmental and social performances. Journal of Cleaner Production, **258**, 120613, **2020**.
14. WANG D., DONG Q., PENG Z., KHAN S.A.R., TARASOV A. The green logistics impact on international trade: Evidence from developed and developing countries. Sustainability, **10** (7), 2235, **2018**.
15. ZHANG W., ZHANG M., ZHANG W., ZHOU Q., ZHANG X. What influences the effectiveness of green logistics policies? A grounded theory analysis. Science of The Total Environment, **714**, 136731, **2020**.
16. GAN W., YAO W., HUANG S. Evaluation of Green Logistics Efficiency in Jiangxi Province Based on Three-Stage DEA from the Perspective of High-Quality Development. Sustainability, **14** (2), 797, **2022**.
17. BARUT A., CITIL M., AHMED Z., SINHA A., ABBAS S. How do economic and financial factors influence green logistics? A comparative analysis of E7 and G7 nations. Environmental Science and Pollution Research, **2022**. DOI: 10.1007/s11356-022-22252-0.
18. WANG Y., XIN L. The impact of China's trade with economies participating in the Belt and Road Initiative on the ecological total factor energy efficiency of China's logistics industry. Journal of Cleaner Production, **276**, 124196, **2020**.
19. LI M., WANG J. Spatial-temporal evolution and influencing factors of total factor productivity in China's logistics industry under low-carbon constraints. Environmental Science and Pollution Research, **29** (1), 883, **2022**.
20. GOEL R.K., SAUNORIS J.W., GOEL S.S. Supply chain performance and economic growth: The impact of COVID-19 disruptions. Journal of Policy Modeling, **43** (2), 298, **2021**.
21. GOCER A., OZPEYNIRCI O., SEMIZ M. Logistics performance index-driven policy development: An application to Turkey. Transport Policy, **124**, 20, **2022**.
22. KIM S.E., KIM H., CHAE Y. A new approach to measuring green growth: Application to the OECD and Korea. Futures, **63**, 37, **2014**.
23. CHEN Y., ZHANG M., ZHANG Y. Evaluation of the development level of low-carbon logistics in Beijing. Environmental Engineering and Management Journal, **14** (8), 1829, **2015**.
24. FONCHAMNYO D.C., DINGA G.D., NGUM V.C. Revisiting the nexus between domestic investment, f oreign direct investment and external debt in SSA countries: PMG-ARDL approach. African Development Review-Revue Africaine De Developpement, **33** (3), 479, **2021**.
25. HWANG K.I. The pro-competitive effects of foreign firm entry: Evidence from the Korean retail sector. World Economy, **45** (5), 1587, **2022**.

26. SINGHANIA M., SAINI N. Demystifying pollution haven hypothesis: Role of FDI. Journal of Business Research, **123**, 516, **2021**.
27. SHAS S.H., HASNAT H., COTTRELL S., AHMAD M.H. Sectoral FDI inflows and domestic investments in Pakistan. Journal of Policy Modeling, **42** (1), 96, **2020**.
28. HU Y., FISHER-VANDEN K., SU B. Technological spillover through industrial and regional linkages: Firm-level evidence from China. Economic Modelling, **89**, 523, **2020**.
29. LATORRE M.C., YONEZAWA H., ZHOU J. A general equilibrium analysis of FDI growth in Chinese services sectors. China Economic Review, **47**, 172, **2018**.
30. SARKODIE S.A. Failure to control economic sectoral inefficiencies through policy stringency disrupts environmental performance. Science of The Total Environment, **772**, 145603, **2021**.
31. AHMAD M., JABEEN G., WU Y. Heterogeneity of pollution haven/halo hypothesis and Environmental Kuznets Curve hypothesis across development levels of Chinese provinces. Journal of Cleaner Production, **285**, 124898, **2021**.
32. CASTELLANI D., PIERI F. Outward Investments and Productivity: Evidence from European Regions. Regional Studies, **50** (12), 1945, **2016**.
33. BITZER J., GÖRG H. Foreign direct investment, competition and industry performance. The World Economy, **32** (2), 221, **2009**.
34. HAO Y., GUO Y., GUO Y., WU H., REN S. Does outward foreign direct investment (OFDI) affect the home country's environmental quality? The case of China. Structural Change and Economic Dynamics, **52**, 109, **2020**.
35. PAN X., LI M., WANG M., CHU J., BO H. The effects of outward foreign direct investment and reverse technology spillover on China's carbon productivity. Energy Policy, **145**, 111730, **2020**.
36. GAO L., LIU X., ZOU H. The role of human mobility in promoting Chinese outward FDI: A neglected factor?. International Business Review, **22** (2), 437, **2013**.
37. PIPEROPOULOS P., WU J., WANG C. Outward FDI, location choices and innovation performance of emerging market enterprises. Research Policy, **47** (1), 232, **2018**.
38. SANTOS A., FORTE R. Environmental regulation and FDI attraction: A bibliometric analysis of the literature. Environmental Science and Pollution Research, **28** (7), 8873, **2021**.
39. MUHAMMAD B., KHAN S. Effect of bilateral FDI, energy consumption, CO_2 emission and capital on economic growth of Asia countries. Energy Reports, **5**, 1305, **2019**.
40. XU S., LI Y., ZHANG J., WANG Y., MA X., LIU H., WANG H., TAO Y. Do foreign direct investment and environmental regulation improve green technology innovation? An empirical analysis based on panel data from the Chinese manufacturing industry. Environmental Science and Pollution Research, **28** (39), 55302, **2021**.
41. PORTER M.E. Towards a dynamic theory of strategy. Strategic Management Journal, **12**, 95, **1991**.
42. ZHOU Y., JIANG J., YE B., HOU B. Green spillovers of outward foreign direct investment on home countries: Evidence from China's province-level data. Journal of Cleaner Production, **215**, 829, **2019**.
43. LIU L., ZHAO Z., ZHANG M., ZHOU C., ZHOU D. The effects of environmental regulation on outward foreign direct investment's reverse green technology spillover: Crowding out or facilitation?. Journal of Cleaner Production, **284**, 124689, **2021**.
44. HANSEN B E. Threshold effects in non-dynamic panels: Estimation, testing, and inference. Journal of Econometrics, **93** (2), 345, **1999**.
45. WANG C., XU M., OLSSON G., LIU Y. Characterizing of water-energy-emission nexus of coal-fired power industry using entropy weighting method. Resources, Conservation and Recycling, **161**, 104991, **2020**.
46. SAPKOTA P., BASTOLA U. Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America. Energy Economics, **64**, 206, **2017**.
47. ZHANG J., WU G., ZHANG J. The estimation of China's provincial capital stock: 1952-2000. Economic Research Journal, **10**, 35, **2004** [In Chinese].
48. AIKEN L.S., WEST S.G. Multiple regression, testing and interpreting interactions. The Journal of the Operational Research Society, **45** (1), 119, **1994**.
49. GAGLIO C., KRAEMER-MBULA E., LORENZ E. The effects of digital transformation on innovation and productivity: Firm-level evidence of South African manufacturing micro and small enterprises. Technological Forecasting and Social Change, **182**, 121785, **2022**.
50. ZHENG W., XU X., WANG H. Regional logistics efficiency and performance in China along the Belt and Road Initiative: The analysis of integrated DEA and hierarchical regression with carbon constraint. Journal of Cleaner Production, **276**, 123649, **2020**.
51. ZHANG J., CHANG Y., ZHANG L., LI D. Do technological innovations promote urban green development? - A spatial econometric analysis of 105 cities in China. Journal of Cleaner Production, **182**, 395, **2018**.
52. LONG R., OUYANG H., GUO H. Super-slack-based measuring data envelopment analysis on the spatial - temporal patterns of logistics ecological efficiency using global Malmquist Index model. Environmental Technology & Innovation, **18**, 100770, **2020**.
53. KHAN S.A.R., DONG Q. Does national scale economic and environmental indicators spur logistics performance? Evidence from UK. Environmental Science and Pollution Research, **24** (34), 26692, **2017**.
54. GUO M., LI H., LIN W. The impact of economic growth, FDI, and innovation on environmental efficiency of the logistics industry in provinces along the belt and road in China: An empirical study based on the panel Tobit model. Science Progress, **104** (2), 00368504211018054, **2021**.
55. ALI U., LI Y., WANG J., YUE X., CHANG A.C. Dynamics of outward FDI and productivity spillovers in logistics services industry: Evidence from China. Transportation Research Part E-Logistics and Transportation Review, **148**, 102258, **2021**.
56. PENG Y., CHEN Y., HOU Y. LI S. China's logistics green competitiveness promotion path: A fuzzy-set qualitative comparative analysis approach. Environmental Science and Pollution Research, **2022**. DOI: 10.1007/s11356-022-22090-0.
57. VANDENBUSSCHE J., AGHION P., MEGHIR C. Growth, distance to frontier and composition of human capital. Journal of Economic Growth, **11** (2), 97, **2006**.
58. LUO S., SHI Y., SUN Y., ZHAO Z., ZHOU G. Can FDI and ODI two-way flows improve the quality of economic

growth? Empirical Evidence from China. Applied Economics, **53** (44), 5028, **2021**.
59. ADNAN Z., CHOWDHURY M., MALLIK G. Determinants of total factor productivity in Pakistan: A time series analysis using ARDL approach. International Review of Applied Economics, **34** (6), 807, **2020**.
60. WANG H., LIU H. Foreign direct investment, environmental regulation, and environmental pollution: An empirical study based on threshold effects for different Chinese regions. Environmental Science and Pollution Research, **26** (6), 5394, **2019**.