Hindawi
Mobile Information Systems
Volume 2023, Article ID 9859123, 1 page
https://doi.org/10.1155/2023/9859123

Retraction

Retracted: The Impact of Environmental Regulation on China's OFDI: From the Perspective of Home Country

Mobile Information Systems

Received 1 August 2023; Accepted 1 August 2023; Published 2 August 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Li and C. Liang, "The Impact of Environmental Regulation on China's OFDI: From the Perspective of Home Country," *Mobile Information Systems*, vol. 2022, Article ID 3322324, 18 pages, 2022.

Hindawi
Mobile Information Systems
Volume 2022, Article ID 3322324, 18 pages
https://doi.org/10.1155/2022/3322324

Research Article

The Impact of Environmental Regulation on China's OFDI: From the Perspective of Home Country

Xiaoyong Li[1] and Caiyi Liang[2]

[1]*School of Management and Economics, Jingdezhen Ceramic University, Zhiyuan Road, Jingdezhen 333403, Jiangxi, China*
[2]*School of Management, Xiamen University, 422 Siming South Road, Xiamen 361005, Fujian, China*

Correspondence should be addressed to Caiyi Liang; caiyi@stu.xmu.edu.cn

Received 24 August 2022; Revised 22 September 2022; Accepted 27 September 2022; Published 10 October 2022

Academic Editor: Chia-Huei Wu

Since China entered the stage of high-quality development, how to promote economic development and high-level protection of the ecological environment in a coordinated manner and implement the new development concept of "innovation, coordination, green, openness, and sharing" is the country's problem need to break through. Based on the connotation of the evolutionary logic of environmental regulation, this paper attempts to build a more scientific indicator of China's environmental regulation and discusses the environmental regulation motivation of China's OFDI from the home country's perspective. The results show that the impact of environmental regulation on China's OFDI presents a significant inverted U-shaped relationship, and there are significant regional differences. The types of environmental regulation have different impacts on OFDI. Porter's hypothesis exists in the influence path of environmental regulation on OFDI. The research in this paper can help coordinate the development of high-quality economic development, environmental protection, and the new pattern of wide opening up in China.

1. Introduction

As one of the most typical international economic activities, outward foreign direct investment (OFDI) has important strategic significance to both countries and enterprises and is also an important part of China's "going out" strategy. Since implementing the "going out" strategy, China's OFDI has entered a period of rapid development. It has become one of the world's most important foreign investment exporting countries. According to statistics from the Ministry of Commerce of China, China became a net capital exporter for the first time in 2014; in 2016, the flow of OFDI reached US$196.1 billion, a record high; in 2020, China's flow ranked first among countries in the world, and its stock ranked second three. OFDI has significantly promoted China's domestic industrial upgrading, easing the constraints of resource bottlenecks in economic development and enhancing China's international influence[1]. In the context of the continuous expansion of the scale and location of OFDI by Chinese companies, a question that provokes thinking is what are the driving factors for Chinese companies to make foreign investment decisions? There has been much research in the academic circles in response to this problem.

To sum up, the existing research stuides mainly analyze the motivation of Chinese enterprises' foreign investment behaviors in the following categories: acquisition of natural resources, acquisition of strategic assets, market acquisition, home country institutional promotion, the attraction of the host country's institutional quality, and the attraction of the host country's preferential policies [1], and these motivations have been verified to varying degrees in theory and experience. So, apart from the motives mentioned earlier, are other factors driving China's OFDI activity?

A real phenomenon is that China's OFDI is highly consistent with the intensity of domestic environmental regulation. The Chinese government has continuously strengthened environmental regulation by formulating, revising, and improving various environmental policies and regulations. For example, China revised the Environmental Protection Law of the People's Republic of China in 2021,

known as the "strictest" environmental protection law in history. The report of the 19th National Congress of the Communist Party of China also put forward the requirement of "implementing the strictest ecological environment protection system" and "treating the ecological environment as life" and further put forward the new development concept of "innovation, coordination, green, open, and sharing." Theoretically, environmental regulation is a means taken by the government to solve the external diseconomies of the environment. Under the regulation, enterprises will reallocate the original production resources to maximize profits. According to the existing research on the impact of environmental regulation on enterprise decision-making, there may be three results after enterprises reallocate production resources: reduced production, transferred production, and innovative production. Among them, the international transfer of production in the second result belongs to a typical outward direct investment activity. According to the theory of enterprise heterogeneity in international trade [2], the improvement of enterprise productivity will stimulate enterprises to invest overseas, so the third result may also lead enterprises to make OFDI decisions. Therefore, on the theoretical level, there is a close relationship between environmental regulation and enterprises' OFDI.

Combining those mentioned above, domestic and foreign practical backgrounds and related theoretical backgrounds, a topic that needs to be discussed naturally arises: (1) is there a certain significant causal relationship between the continuous expansion of China's OFDI activities and the continuous improvement of the domestic environmental regulation intensity? That is, driven by China's rapid economic development, has China's OFDI been affected by the strengthening of domestic environmental regulations? (2) If so, what is the path of the impact of domestic environmental regulation on OFDI behavior? Based on this, this article will be based on the changes in China's environmental regulations and the actual situation of the development of OFDI, combined with the existing relevant theoretical research and empirical research, to deeply explore the possible relationship between environmental regulation and China's OFDI and to enrich the theoretical research of China's f OFDI. The research on the motives of OFDI also provides certain references and references for the government to formulate relevant policies and enterprises to make overseas business decisions.

2. Literature Review

2.1. Research on Environmental Regulation Measures. According to the current research literature, measuring the intensity of environmental regulation can be roughly divided into three categories: qualitative index measurement methods, single index quantitative measurement methods, and comprehensive index quantitative measurement methods.

The qualitative indicator measurement method relies on subjective scoring. In the early stage of environmental regulation research, many scholars chose to use qualitative index measurement algorithms to measure the intensity of environmental regulation due to insufficient statistical data on the environment in various countries [3–5]; with the continuous improvement of environmental statistics in various countries, there are fewer and fewer scholars using qualitative measurement methods to conduct research at this stage.

The measurement method of a single quantitative indicator refers to selecting a specific indicator to measure the environmental regulation intensity of a country, region, industry, or individual. This method has the advantages of strong pertinence and easy horizontal comparison. The indicators of the single quantitative index measurement method are mainly selected from the following five perspectives: the perspective of pollutant emissions [6, 7], the perspective of pollution emissions tax [8, 9], the perspective of pollution control [10–12], and the perspective of environmental laws and regulations [13, 14].

Although the measurement algorithm of a single indicator is highly targeted, each indicator can only reflect some aspects of environmental regulation, which may easily lead to biased research conclusions [15]. Therefore, many scholars try to build a comprehensive index system of environmental regulation to reflect the overall situation of environmental regulation more comprehensively and comprehensively. For example, Dam and Scholtens [16] divided the whole process of environmental regulation into four dimensions: policy formulation, regulation management, environmental improvement, and regulation performance; used factor analysis to give weights to these four dimensions; and finally obtained a comprehensive environmental regulation intensity. Wang et al. [17] use the newly developed OECD Environmental Policy Stringency Composite Index (EPS) to measure the intensity of environmental regulation across countries. The composite index consists of two parts: market-based environmental policy and non-market-based environmental policy. Chen et al. [18] comprehensively measured the environmental regulation strength of China's provinces according to the emissions of major industrial pollution.

2.2. Research on Environmental Regulation and OFDI. Existing research on the effects of international investment in environmental regulation is divided into the "Porter Hypothesis" test and the "Pollution Refuge Hypothesis" test. The key factor in the "Special Hypothesis" test, productivity, is also directly related to international investment [2].

The "Pollution Shelter Hypothesis" has always been one of the most controversial issues in the field of international trade and investment [19]. This hypothesis believes that, under the opening and integration of the global economy, the difference in the intensity of environmental regulation is an important factor in the international transfer of pollution-intensive industries, and these industries will shift from countries with strict environmental regulations to countries with loose environmental regulations for production [3]. After the "Pollution Shelter Hypothesis" was put forward, many scholars used data from different countries and

industries to verify the hypothesis and obtained different conclusions. To sum up, scholars' conclusions on the verification of the "pollution shelter hypothesis" can be divided into three results: established [20, 21], not established [22, 23], and uncertain [24, 25].

The so-called "Porter Hypothesis" means that strict environmental regulation will force enterprises to innovate, compensating for environmental compliance costs. Moderate intensity of environmental regulation can benefit enterprise productivity, thereby achieving environmental protection and economic efficiency. After the "Porter Hypothesis" was put forward, many scholars began to study the relationship between environmental regulation and productivity based on this hypothesis. However, the conclusions of the studies were quite different. On the whole, scholars' conclusions on enterprise productivity can be summarized into the following four types: environmental regulation inhibits the improvement of productivity [26], environmental regulation promotes the improvement of productivity [27, 28], the impact of environmental regulation on productivity is nonlinear [17], and the impact of environmental regulation on productivity is uncertain [6, 29].

2.3. Research on the Impact of Home Country Environmental Regulation on OFDI. As mentioned earlier on the "pollution shelter hypothesis" test, the literature mainly focuses on the impact of one country's environmental regulation on another country's OFDI. In contrast, the literature on its impact on the home country's OFDI from the home country's perspective is still relatively small and mainly focus on the research on developed countries. Spatareanu [30] studied the impact of the intensity of environmental regulation in 25 European countries on the establishment of subsidiaries overseas. She found that the stricter the environmental regulation of the home country, the greater the possibility of the country's OFDI, and this phenomenon is at a high level. Enterprises in polluting industries are more obvious. Elliott and Shimamoto [31] used industry data to study the impact of improving Japan's domestic environmental regulation intensity on OFDI. Kneller and Manderson [32] used enterprise data to study the impact of UK environmental regulation on the location choice of UK multinationals' outbound investments. Companies with high environmental compliance costs cannot invest in loose environmental regulations.

Through literature review, we have the following findings: (1) in the existing research on the impact of environmental regulation on productivity and cross-border investment, scholars' research conclusions are quite different, and scholars' research conclusions on the same sample are also different. There are two possible reasons: the difference in measurement methods and model setting; the other is the difference in the measurement of environmental regulation indicators. The environmental regulation indicators used by scholars vary widely, which requires future research to consider how to construct a scientific model, a comprehensive and systematic environmental regulation index system, to achieve the goal of accurately measuring the true intensity of environmental regulation. (2) The existing research on the impact of environmental regulation on transnational investment is mainly to verify the existence of the "pollution shelter hypothesis" and rarely considers the "Porter hypothesis." Suppose the "Porter Hypothesis" is established. In this case, environmental regulation can improve the productivity of domestic enterprises, and according to the New New Trade Theory, the improvement of enterprise productivity is conducive to enterprises' OFDI activities. That is to say, in the existing research on the testing of the "pollution shelter hypothesis," many scholars may have ignored the possible action pathway of the "Porter hypothesis." Therefore, it is necessary to consider this action pathway in future research. There is still little literature on the impact of OFDI from the home country's perspective, and they mainly focus on the research on developed countries. We know there are significant differences between China and developed countries in many fields (such as economy, politics, and culture), which may lead to different effects of China's environmental regulation on foreign investment from developed countries. Therefore, it is necessary to conduct research on this issue in China. The above three points are also the innovations of this paper.

3. Construction and Calculation of China's Environmental Regulation Index System

3.1. The Connotation of Environmental Regulation. According to the difference in the time and mechanism of regulation, the evolution of the connotation of environmental regulation can be divided into four stages: command-and-control environmental regulation, market-based environmental regulation, information disclosure-based environmental regulation, and implicit environmental regulation, but the relationship between these four stages is not a hierarchical substitution, but based on the previous stage, the connotation of environmental regulation is continuously expanded, supplemented, and perfected, so that it can meet the new requirements of the continuous change and development of social and economic activities. By comparing, it can be seen that the regulatory subject of environmental regulation has changed from being single (only the government) to diversified (government, enterprises, the public, etc.). The current voluntary regulation (such as information disclosure regulation) and mandatory regulation coexist; regulation changes from concrete and tangible to abstract and intangible (implicit environmental regulation); the theoretical basis of regulation also continues with the development of economic disciplines rich. Although these four types of environmental regulation are different in many aspects, they are all designed to regulate pollution behaviors to achieve the purpose of environmental protection. They form an environmental regulation system and can influence, integrate, and transform each other. For example, the long-term implementation of command-and-control environmental regulations can promote the formation of people's environmental protection concepts and improve environmental protection awareness. The continuous promotion of information disclosure may also speed

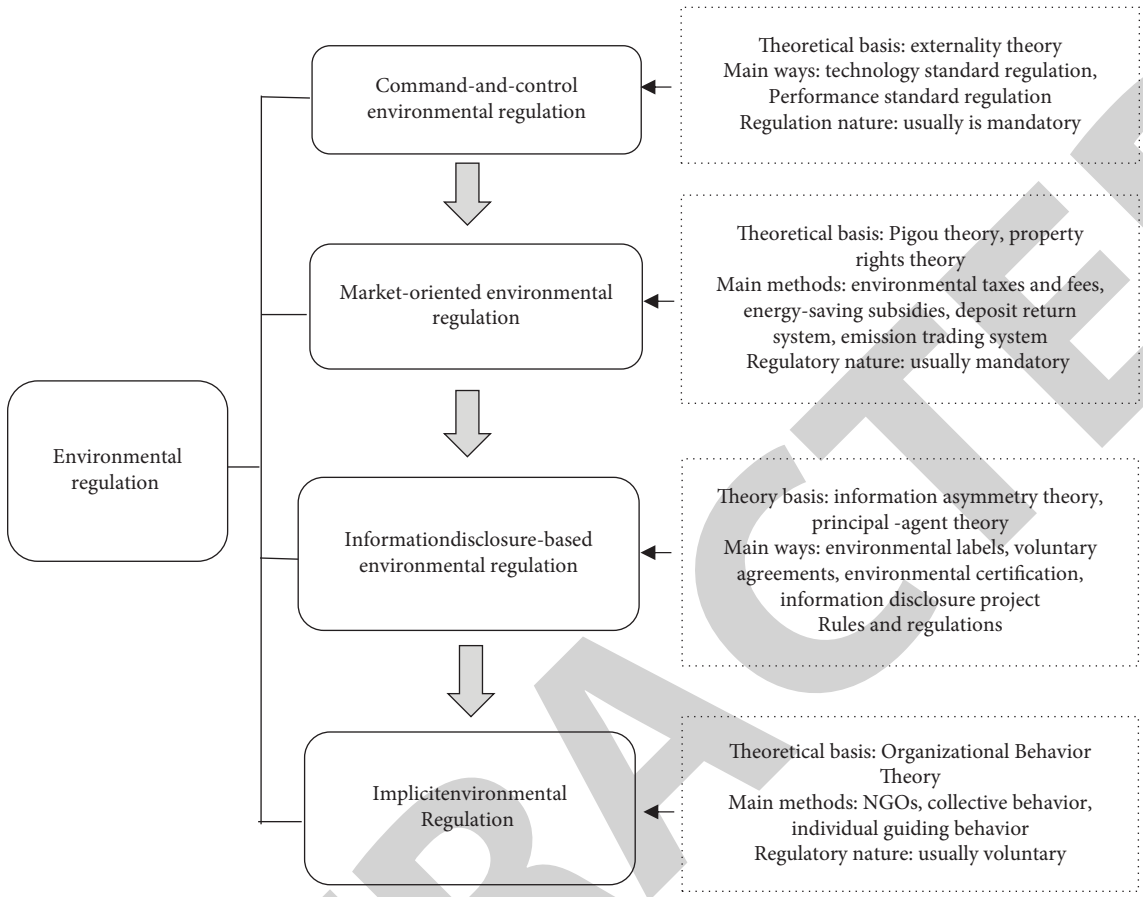

Figure 1: The connotation of environmental regulation changes.

up the politicization of information disclosure. The evolution process of the connotation of environmental regulation can be summarized as shown in Figure 1.

In the previous literature on environmental regulation from the perspective of environmental regulation types, only two or three of the above four types of regulations are usually considered. Each type uses only a single indicator to measure environmental regulation in fundamental analysis. Almost all of them only focus on the heterogeneity between different types of environmental regulation but do not integrate different environmental regulation indicators. We believe that the above research methods are not rigorous enough, mainly for the following four points: first, different types of environmental regulations can be transformed and influenced by each other. Taking carbon emission reduction as an example, China has always been promoting the concept of low carbon, but there are no coercive measures, which is a typical recessive environmental regulation. With the proposal of the "double carbon" goal in 2020, China's regulations on carbon emissions are already mandatory and market-oriented environmental regulations. Second, the economic behavior of the regulation object (such as enterprises) is a choice made under the constraints of all regulation types, not a single regulation type. Third, a single indicator often only reflects part of environmental regulation connotative characteristics, if only a single indicator is used to measure different types of regulations, the measurement results will be incomplete [33]. Fourth, these previous studies based on the type of regulation mainly focus on the customization of environmental regulations, and the implementation and actual effects of environmental regulations are not enough. Attention, but not too much attention to the emission reduction effect of environmental regulation.

Therefore, based on the previous research, we combine the four types of environmental regulation. From the perspective of the regulatory leaders of different types of regulation, it sets out to build a comprehensive index system for provincial environmental regulation. Specifically, when constructing a comprehensive index system of provincial environmental regulation, we take environmental regulation as the target layer, select government-led regulation, market-led regulation, public-led regulation, and regulation efficiency as the four first-level indicators, and take environmental regulation as the target. Several secondary indicators are selected under each primary indicator, thereby constructing a rational and scientific indicator system with clear levels, wide coverage, and rationality. The dimension of

government-led regulation includes not only the indicators of command control regulation in previous studies, but also the indicators of government's active governance environment.The dimension of market-led regulation is mainly aimed at the market-oriented environment regulation. The dimension of public-led regulation fully reflects the implicit environmental regulation and part of information disclosure environmental regulations. The dimension of regulation efficiency makes up for the lack of previous studies that did not pay enough attention to environmental regulation's implementation degree and actual effects. Next, this article will introduce and analyze the composition of the second-level indicators under each first-level indicator in detail.

3.2. A Specific Selection of Comprehensive Indicators of Environmental Regulation

3.2.1. Selection of Government-Led Regulation Indicators. The government plays an important role in formulating, implementing, and supervising environmental regulations. Considering the welfare of the whole society, the government restrains the behavior of economic individuals by formulating specific measures and targets of environmental regulation; strengthen the supervision and management of emission compliancethrough laws, regulations, administrative, and other coercive means; take the initiative to control environmental pollution sources by invoking social resources. The government-led environmental regulation and control measures have the advantages of impartiality, objectivity, and compulsory implementation, which play an important role in promoting environmental protection. In particular, since the beginning of the 21st century, China has taken concrete measures such as improving environmental laws and regulations, strengthening environmental supervision, and expanding investment in environmental protection, thus raising the level of environmental regulation and protection in China as a whole. Based on this, combined with the principle of data availability, we selected four government-led environmental regulation indicators, including the number of environmental protection laws and regulations, the number of environmental administrative penalty cases, the proportion of environmental protection agency personnel per 10,000 civil servants, and the proportion of government pollution control investment in financial expenditure.

(1) Number of environmental protection laws and regulations: the number of laws and regulations on environmental protection is the most direct reflection of the intensity of environmental regulation. The more laws and regulations on environmental protection in a region, the stronger the will of the government to govern the environment and the greater the degree of environmental regulation. Various areas of the data mainly include the number of comprehensive environmental regulations, environmental standards and regulations issued by the quantity, the number of environmental monitoring regulations, pollution prevention regulations, quantity conservation laws, and illegal processing amount, respectively, from the local, regional regulations and local government regulations, local regulatory documents, the local judicial documents, local files, and administrative licensing approval work. The data came from the Peking University magic database, which the author collected and sorted.

(2) The number of environmental administrative penalty cases: environmental administrative penalty refers to citizens, legal persons, or other organizations violating environmental protection laws, regulations, or rules and regulations. The competent environmental protection authorities have the right to give an environmental administrative penalty to the following relevant laws. It can reflect the supervision degree of the government on environmental regulations to a certain extent. The higher the number of environmental administrative penalty cases, the higher the government's supervision of environmental regulation, and the greater the intensity of environmental regulation. The data come from the China Environmental Yearbook.

(3) Proportion of environmental protection agency staff per 10,000 civil servants. Environmental protection agency personnel refer to all employees working in environmental protection departments at all levels in China. Their work aims to ensure the effective implementation of relevant environmental protection laws and regulations in the region, and they are responsible for environmental enforcement and supervision. The difference is bigger considering the different areas in the population, economy, and various aspects. We introduced the proportion of environmental protection agency staff per 10,000 civil servants, so the factor is comparable. The index indicated the importance attached to environmental protection work. The number of environmental protection institutions personnel in each region came from the China Environmental Yearbook. The number of public officials in each region came from the Wind database.

(4) Proportion of government pollution control investment in financial expenditure. Government investment in pollution control includes investment in water pollution prevention and control capacity construction, air pollution prevention and control capacity construction, solid waste pollution prevention and control capacity construction, and so on. To reflect the government's emphasis on environmental pollution control, we introduce the government's investment in the pollution control index in the financial expenditure. The larger the value of this index is, the stronger the government's willingness to control the environment and the stronger the environmental regulation. The government investment data in pollution control comes from China Environmental Yearbook, and the total

government financial expenditure data comes from the China Statistical Yearbook.

3.2.2. Selection of Market-Led Regulatory Indicators. As another important leader in environmental regulation, the market also has a huge role and contribution to environmental governance. Unlike mandatory government-led regulation, market-led regulation mainly reallocates economic resources through price and quantity to mobilize the enthusiasm of economic individuals in pollution control and pollution prevention as much as possible to achieve the goal of environmental protection. The currently available data are mainly concentrated in pollution discharge fees, sewage companies, and pollution control investments:

(1) The amount of the pollutant discharge fee paid by the unit enterprise. The Coase theorem believes that the deviation between a company's marginal production cost and society's marginal production cost is an important cause of environmental problems. The collection of sewage charges is a typical application of the Coase theorem in treating environmental problems. The marginal production costs are close, enabling companies to maximize their profits while simultaneously achieving the optimal social level of pollution emissions. Because of the large difference in the number of pollutant companies in different regions, we adopt the indicator of the pollutant discharge fee paid by a unit enterprise. The factor of pollutant fee collection in various regions is comparable. The larger the indicator, the stronger the market-based environmental regulation. The data on the income from pollutant discharge fees and the number of pollutant companies in each region are from the "China Environmental Yearbook."

(2) Investment in pollution-control enterprises. Investment in pollution control refers to investment in the prevention and control of industrial Pollution in various regions include subsidies for sewage discharge fees, other subsidies from the government, and investments raised by enterprises. It refers to enterprises' total funds to control wastewater, waste gas, solid waste, noise, and other environmental pollution (electromagnetic waves and stench). As profit-maximizing pursuers, enterprises have two main motives for investment in pollution control. One is to meet the mandatory requirements of national and local environmental protection. The other is to reduce pollutant discharge fees or environmental tax expenditure after meeting the standards. Because of the large difference in the number of polluters in different regions, we adopt the investment index in pollution control by unit polluters to make the investment factor in pollution control in different regions comparable. The larger the index is, the stronger the market-based environmental regulation is. The investment data for industrial pollution prevention and control and the number of polluting enterprises in each region were obtained from the China Environmental Yearbook.

3.2.3. Selection of Public-Led Regulatory Indicators. With the continuous improvement of the public's awareness of environmental protection in our country, the public supervision system of our country has gradually formed, and the social public-led regulation has gradually developed into an important way of environmental governance in our country. In theory, public-led regulation is a useful and necessary supplement to government and market-led regulation. The public's environmental awareness and behavior can significantly impact the production decision-making of enterprises, such as the public's demand for environmentally friendly products ̄ public condemnation of environmental pollution and participation in environmental legislation ,etc. This article selects four secondary indicators, including the number of environmental letters and visits, environmental news reports, Internet penetration rate, and environmental proposals undertaken by the two sessions to represent the public-led regulatory indicators:

(1) The number of environmental petitioners. Environmental complaints and visits mainly refer to the public's response to pollution emissions, ecological damage, and other issues to governments at all levels, especially environmental protection departments, through mailing letters, sending e-mails, dialing reports, and visiting. It is an effective way for the public to participate in environmental governance. The greater the number of environmental petitioners, the greater the intensity of public-led regulations. The data comes from the "China Environmental Yearbook."

(2) The number of environmental news reports. Environmental news reporting refers to the timely reporting of new environmental rules and regulations through public media and other channels, publicizing the effectiveness of environmental governance and publicizing organizations or individuals that violate environmental governance to stimulate the public's awareness of environmental protection. The more environmental news reports, the more conducive to raising the public's awareness of environmental protection, and the greater the intensity of public-led regulations. The data are obtained by filtering and cleaning after entering keywords such as "environmental pollution, environmental protection, and ecological environment" in the reports of our party organs.

(3) Internet penetration rate. With the rapid spread of the Internet in our country, more and more public members use it to obtain environmental-related information and express their views on environmental events and problems. Supervising public opinion on the Internet has gradually become important environmental governance. Under the pressure of Internet public opinion, enterprises will pay attention to environmental protection images to avoid the spreading effect. In addition, the Internet

can also play an important role in learning environmental protection knowledge for the general public, thereby benefiting the environmental protection of the entire region. Considering the large differences in population numbers in different regions, we use the Internet penetration rate as an indicator. The larger the indicator, the greater the intensity of social-led regulations. Among them, the data on the number of Internet users in each region come from the "Statistical Report on China's Internet Development Status" issued by the China Internet Network Information Center (CNNIC), and the total population data in each region comes from the "China Statistical Yearbook."

(4) The number of environmental proposals received during the two sessions. The NPC and CPPCC sessions are important to China's socialist political construction. They have played an extremely important role in supervising government administration, and the rate of undertaking proposals for the TWO sessions is increasing. The NPC deputies and CPPCC members can timely reflect on social-environmental problems and submit environmental proposals at the two sessions to improve the government's attention to environmental issues and governance, which is also an effective way for the public to participate in environmental governance. Therefore, we introduce the number of environmental proposals undertaken during the TWO sessions, including the number of suggestions of the National People's Congress and the number of CPPCC proposals undertaken. Among them, the number of suggestions from the National People's Congress and the number of proposals from the CPPCC are all from the China Environmental Yearbook.

3.2.4. Selection of Regulatory Efficiency Indicators. From the perspective of "regulatory input-output," the indicators in government-led regulation, market-led regulation, and public-led regulation are "regulatory input" indicators, such as the number of laws and regulations, the number of environmental protection agency personnel, pollution control investment, the number of environmental proposals from the two sessions, and the number of letters and visits. These indicators all represent China's investment in environmental regulation. However, they cannot reflect the actual effect of regulation, whether pollution emissions are reduced. In other words, the above three dimensions lack "regulation output-type" indicators. We select three secondary indicators from the regulatory efficiency dimension to represent the "regulation output-type" indicators: industrial wastewater discharge, industrial waste gas discharge, and industrial solid waste discharge.

(1) Unit industrial wastewater discharge. Industrial wastewater discharge refers to the amount of industrial wastewater discharged to the outside of the company through all the discharge outlets of the company's plant within a certain period, including production wastewater, direct cooling water discharged outside, underground mine water discharged more than standard, and plant life mixed with industrial wastewater. Sewage does not include indirect cooling water discharged outside (indirect cooling water with clean sewage and nonsplitting shall be included in the wastewater discharge amount). We adopt the indicator of unit industrial wastewater discharge. The larger the value of this indicator, the lower the regulatory efficiency in the region, that is, the weaker the environmental regulation. Each region's total industrial wastewater discharge comes from the "China Environmental Statistical Yearbook." The data on the industrial added value of each region come from the "China Statistical Yearbook."

(2) Unit industrial waste gas emissions. Industrial waste gas emissions refer to the total amount of pollutant-containing gases discharged into the air during the fuel combustion and production processes in the factory area, including smoke, odor, irritating gases, and other harmful gases. To eliminate the differences in the economic development level of different regions, we adopt the indicator of industrial waste gas emissions per unit. The larger the value of this indicator, the lower the regulatory efficiency in the region, that is, the weaker the environmental regulation. Among them, the data on the total industrial waste gas emissions in each region come from the "China Environmental Statistical Yearbook," and the data on the industrial added value of each region come from the "China Statistical Yearbook."

(3) Discharge volume of industrial solid waste per unit. Industrial solid waste discharge refers to the amount of solid waste discharged outside solid waste pollution prevention facilities and sites in industrial production activities. It did not include stripped waste rock and excavated waste rock (except for coal gangue and waste rock that is acidic or alkaline). To eliminate the differences in the economic development level of different regions, we adopt the indicator of unit industrial solid waste discharge. The larger the value of this indicator, the lower the regulatory efficiency in the region, that is, the weaker the environmental regulation. Each region's total industrial solid waste discharge comes from the "China Environmental Statistical Yearbook." The data on the industrial added value of each region come from the "China Statistical Yearbook."

This article has constructed a new comprehensive system for China's provincial environmental regulation by describing and selecting the above 4 first- and 13 second-level indicators. This article has constructed a new comprehensive indicator system for China's provincial environmental regulation, as shown in Table 1. The table includes each indicator's name and the unit's first-level indicator attribute. The positive indicator attribute means that the greater the

Table 1: Comprehensive index system of provincial environmental regulation.

Target layer	First-level indicator	The secondary indicators	Unit	Indicator attributes
Provincial environmental regulation comprehensive index	Government-led	Number of environmental protection laws and regulations (X1)	Number	Positive
		Number of environmental administrative punishment cases (X2)	Number	Positive
		The proportion of environmental protection agency personnel per 10,000 civil servants (X3)	Person/10000 persons	Positive
		The proportion of government investment in pollution control in financial expenditure (X4)	%	Positive
	Market-led	The amount of pollutant discharge fee paid by the unit enterprise (X5)	Ten thousand yuan/household	Positive
		Investment amount of pollution control by unit pollutant discharge enterprise (X6)	Ten thousand yuan/household	Positive
	Public-led	Number of environmental letters and visits (X7)	Person	Positive
		Environmental news reports (X8)	Time	Positive
		Internet penetration rate (X9)	%	Positive
		Number of environmental proposals undertaken by the two sessions (X10)	Number	Positive
	Regulatory efficiency	Unit industrial wastewater discharge (X11)	10,000 tons/100 million yuan	Negative
		Unit industrial waste gas emissions (X12)	100 million standard cubic meters/100 million yuan	Negative
		Unit industrial solid waste discharge (X13)	10,000 tons/100 million yuan	Negative

Note. The author sorted it out based on relevant analysis.

value of the indicator, the stronger the environmental regulation; the opposite is true.

3.3. Calculation Result and Analysis of the Comprehensive Index of Environmental Regulation. We calculate the intensity of provincial environmental regulation based on the entropy method and the comprehensive index system. Due to the serious lack of relevant data on the Tibet Autonomous Region, Tibet Autonomous Region was excluded from calculating provincial environmental regulation intensity. In addition, we select the period from 2003 to 2015 for calculation, mainly for two reasons: first, the statistical work of OFDI data in various regions of China began in 2003, so the starting point of time is set as 2003 for the convenience of subsequent analysis; second, there is no data of industrial wastewater and industrial waste gas emissions of each region in China Environmental Yearbook 2017, that is, the data of these two indicators are missing in 2016 (note: it should be noted that there is no industrial waste water and industrial waste gas emission data of each region in 2016 in China Environmental Yearbook 2017, while the two data are included in China Statistical Yearbook 2017; however, we do not choose to use the data in China Statistical Yearbook 2017 because before 2011, these two data in the China Environment Yearbook and China Statistical Yearbook are exactly the same, but after 2011, both in the China Statistical Yearbook data statistical method has carried on the significant adjustment, and the China Environment Yearbook of statistics difference is huge, so according to the time of unity principle, this article will end time was in 2015). For data integrity, the endpoint of time is set as 2015.

For the intensity of environmental regulation in different regions more intuitively, we draw the variation trend of the average intensity of environmental regulation in different regions of China from 2003 to 2015, as shown in Figure 2. As shown in Figure 2, from 2003 to 2015, the average intensity of environmental regulation in China increased from 0.1019 to 0.2468, showing an obvious upward trend. It shows that since the beginning of the 21st century, China's environmental regulations have become more intensive. More and more attention has been paid to environmental protection, which is also in line with China's development. Furthermore, in order to analyze the differences of environmental regulation intensity in different regions , according to the division of China's Eastern, central and Western "three major zones" by the National Bureau of Statistics, this paper draws the change trend chart of environmental regulation intensity in eastern, central, and western China respectively.As can be seen from the figure, the order of environmental regulation intensity of different regions in China is: East > Central > west, indicating that the more developed regions are, the greater their environmental regulation intensity is, which is also in line with the reality of China.

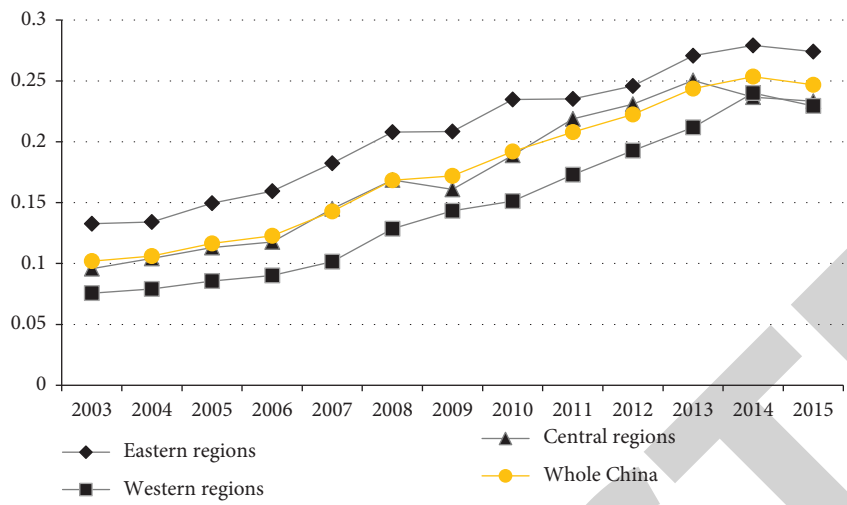

Figure 2: The changing trend of average environmental regulation intensity in various regions of China from 2003 to 2015.

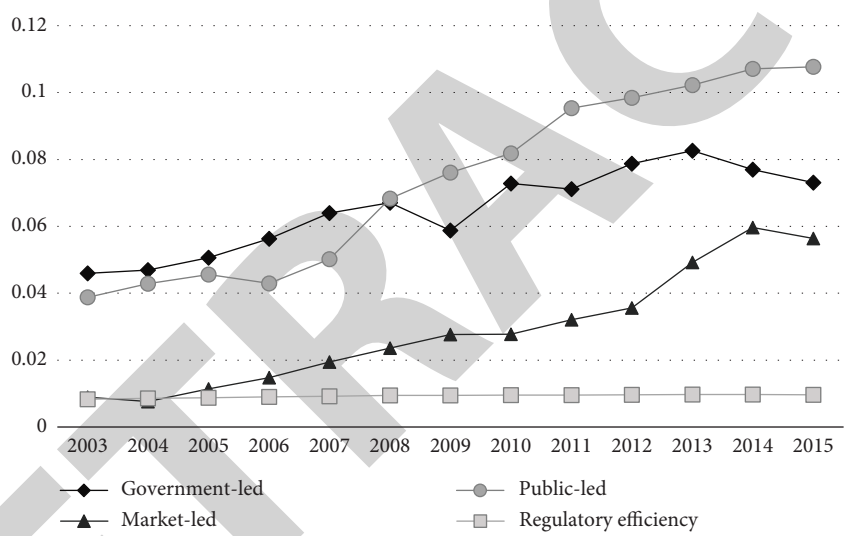

Figure 3: The changing trend of average scores of different types of environmental regulation intensities from 2003 to 2015.

To compare different types of environmental regulations, we decomposed the average score of national environmental regulation intensity into the average score of four first-level indicators according to the weight of each index calculated by the entropy method. We drew the trend chart of the average score of different types of environmental regulation intensity from 2003 to 2015 are shown in Figure 3, the score of government-led regulation ranked first before 2008. However, after 2008, the score of public-led regulation surpassed that of government-led regulation, while the score of market-led regulation ranked third all the time, but its growth rate was fast. China's environmental regulation has gradually changed from the initial government-led regulation to a diversified regulatory situation in which the government-led, market-led, and social public-led play a combined role, and the role of social-public-led and market-led is still increasing. However, from the perspective of regulatory efficiency, China's score on regulatory efficiency remained unchanged from 2003 to 2015. As seen from the calculation results of provincial environmental regulations, the intensity of environmental regulations in eastern China is significantly higher than in central and western China.

4. Model and Data

4.1. The Research Model. Considering the multiple impacts of environmental regulations on OFDI, the impact of environmental regulatory intensity on OFDI may show nonlinear characteristics. So, the quadratic term of environmental regulations is introduced in the measurement model to test the relationship between environmental regulations and OFDI. The measurement model is set as follows:

$$\text{lnof di}_{\text{it}} = \alpha + \beta_1 ER_{\text{it}} + \beta_2 ER_{\text{it}}^2 + X_{\text{it}}\theta + \mu_i + \lambda_t + \varepsilon_{\text{it}}. \quad (1)$$

Model 1: among them, $\text{lnof di}_{\text{it}}$ is the explained variable, which represents the OFDI flow, i province (region, city) in year t; ER_{it} is the core explanatory variable of this article, which means environmental regulation strength to

withstand of i province (region, city) in year t; X_{it} is a control variable group, which contains some economic and social variables that may affect the province's OFDI; μ_i and λ_t are individual fixed effects and time fixed effects, respectively, α is a constant term; β and θ are the parameter to be estimated; ε_{it} is the random disturbance term.

4.2. Data Sources and Variable Interpretation. Considering data availability, we selected 30 provinces for 12 years from 2004 to 2015 (Tibet Autonomous Region was excluded due to incomplete data) as research samples. The original data sources of the variables we used mainly included the China Environmental Yearbook, the Statistical Bulletin of China's OFDI, China Environmental Statistical Yearbook, China Statistical Yearbook, Statistical Yearbook of provinces, Peking University Talisman database, and the collected data of the author. The main variables are as follows:

(1) Explained variable: OFDI flow (ln of di). In previous studies on OFDI, most scholars used flow data, but some scholars believed that compared with flow data, stock data could better reflect the changes in OFDI [34, 35]. Therefore, we will mainly use OFDI flow and OFDI stock data for robustness tests. As the OFDI flow data of some provinces is zero in some years, to retain the data information of these years, logarithmic transformation is carried out according to the method of $m = \ln(m + \sqrt{a^2 + 1})$ by referring to Busse and Hefeker [36] and Chen et al. [37]. Both OFDI flow and stock data come from the Statistical Bulletin of China's OFDI.

(2) Core explanatory variable: environmental regulation (ER). As a core explanatory variable, our environmental regulation index uses the intensity of provincial environmental regulation measured in Section 3.3. The comprehensive index is composed of four first-level indicators: government-led regulation (GovER), market-led regulation (MarER), socio-public-led regulation (SocER), and regulation efficiency (EffER). See Table 1 for specific indicators. In addition, to make the value of environmental regulation equal to that of a dependent variable, the value of environmental regulation is expanded by 100 times, and the value of the quadratic term is expanded by 10,000 times.

(3) Control variables

Previous studies have found that China's OFDI has an obvious host country market-seeking motivation, resource-seeking motivation, and strategic asset-seeking motivation [38, 39]. Some scholars have examined whether these motivations exist from the home country's perspective [40, 41]. We try to improve the accuracy of the model estimation results and reveal the impact of environmental regulation on China's OFDI. The following variables are selected as the control variables of the model based on relevant theories and previous studies: (1) level of economic development (GDPP). The companies try to pursue more markets [37]. The per capita GDP (GDPP) can better reflect the market purchasing power of residents than the GDP [42]. (2) Labor costs (wage). Increasing regional labor costs will stimulate cost-seeking enterprises to conduct overseas investment activities. The average wage of employees is used as a proxy variable of the labor force in each region. (3) Resource demand. The greater the demand for domestic resources, the more likely resource-seeking enterprises are to invest overseas. To investigate the impact of domestic resource demand on OFDI, we use the ratio of total energy consumption to GDP of each province (region, city) to measure resource demand. (4) Human capital (education). The average number of years of education in each province (region or municipality) is measured by the following formula: average number of years of education = (number of primary school students ∗6+ number of junior middle school students ∗9+ number of senior high school students ∗12+ number of junior college students and above ∗16)/total number of students. (5) R&D investment. The proportion of internal expenditure of research funds in GDP is used to measure the R&D investment of provinces. (6) Degree of market. It is expressed as the proportion of fixed asset investment of state and state-owned holding enterprises in society. (7) Trade dependence. Many studies have confirmed the close relationship between international trade and direct investment [43–45]. Therefore, trade dependence is added into the model to measure the importance of trade in the economy of each province (region or city), and the calculation formula is total import and export/GDP.

(4) Descriptive statistics of variables

Table 2 lists the descriptive statistics of all variables.

5. Methods and Empirical Findings

5.1. Empirical Test and Result Analysis. To ensure the effectiveness of the estimated value, before carrying out empirical analysis, we first use the variance inflation factor (VIF) to test the multicollinearity between explanatory variables in the model. As shown in Table 3, all VIF values of explanatory variables are less than 10. There is no multicollinearity problem in the econometric model.

5.2. Benchmark Regression. As a frame of reference, this article first conducts hybrid OLS regression. Subsequently, the Hausman test was performed on the fixed and random effects regression results to determine the model regression method. The test results showed that the null hypothesis was rejected at the 1% significance level, so the fixed effects model should be used. In addition, personal and time effects were also controlled when performing regression.

Table 2: Description of main variables and descriptive statistics.

Variable	Meaning	Mean	Standard deviation	Minimum value	Maximum value
lnOFDI	OFDI	10.232	2.414	0	15.349
ER	Environmental regulation	18.289	7.602	3.098	43.262
GDPP	Economic development	3.323	2.178	0.426	10.796
Wage	Production costs	10.376	0.496	9.381	11.636
Energy	Energy demand	1.166	0.651	0.298	4.323
Education	Human capital	8.589	0.981	6.378	12.081
Research	R & D investment	27.701	50.469	2.639	305.356
Market	Degree of marketization	0.318	0.103	0.114	0.609
Trade	Trade dependence	0.332	0.407	0.036	1.721

Note. the author collated the data according to the original data.

Table 3: Variance inflation factor of each explanatory variable (VIF).

Variable	Meaning	VIF	1/VIF
GDPP	Economic development	6.94	0.144
Wage	Production costs	4.18	0.239
Education	Human capital	4.13	0.242
ER	Environmental regulation	2.26	0.443
Trade	Trade dependence	1.95	0.512
Energy	Energy demand	1.93	0.518
Market	Degree of marketization	1.85	0.546
Research	R&D investment	1.8	0.555
Mean VIF	The mean of VIF	3.13	0.319

Table 4: Baseline regression results.

Variable	(1) OLS1	(2) OLS2	(3) FE1	(4) FE2	(5) FE3	(6) FE4
ER	0.6252***	0.3182***	0.6354	0.1953**	0.2256**	0.1976 * *
	(0.000)	(0.008)	(0.000)	(0.026)	(0.030)	(0.037)
ER2	−0.993***	−0.5077**	−0.984	−0.3786**	−0.433**	−0.3754 * *
	(0.000)	(0.030)	(0.000)	(0.036)	(0.041)	(0.049)
GDPP		0.102		−0.0550		−0.0245
		(0.193)		(0.746)		(0.893)
Wage		1.208**		3.655***		3.105 *
		(0.035)		(0.000)		(0.075)
Energy		−0.808**		0.459		0.426
		(0.012)		(0.511)		(0.553)
Education		−0.0585		−0.239		−0.0439
		(0.865)		(0.404)		(0.921)
Research		−0.00130		−0.000820		−0.000493
		(0.585)		(0.917)		(0.947)
Market		−1.748		−1.934		−1.819
		(0.308)		(0.156)		(0.355)
Trade		0.363		−0.363		−0.236
		(0.262)		(0.540)		(0.766)
_cons	2.665***	−4.587	2.442***	−27.34***	5.131***	−24.06
	(0.003)	(0.288)	(0.005)	(0.003)	(0.000)	(0.137)
Individual trends	—	—	Control	Control	Control	Control
Time trend	—	—	—	—	Control	Control
N	358	358	358	358	358	358
R^2	0.605	0.738	0.672	0.794	0.797	0.804

Note. Clustering robust standard error is used in the regression. The numbers in parentheses below the regression coefficient are significance levels. **, **, and * are significant at 1%, 5%, and 10% significance levels, respectively.

Table 4 reports the benchmark regression results of the impact of environmental regulations and related control variables on China's OFDI. Among them, regression equation (1) is a mixed OLS regression containing only environmental regulations and their quadratic terms; regression equation (2) is a mixed OLS regression containing all control variables; and regression equation (3) is only containing environmental regulations and their quadratic terms. The quadratic term only controls the fixed-effect regression of individual effects; regression equation (4) is a fixed-effect regression that includes all control variables and controls the individual effects; regression equation (5) contains only environmental regulations and their two. The second term is a fixed-effect regression that controls the individual effect and time effect; the regression equation (6) is a fixed-effect regression that includes all control variables and controls the individual effect and time effect. It can be seen from the benchmark regression results in Table 4 that whether it is a mixed OLS regression or a fixed effect, the regression coefficients of the core explanatory variable of environmental regulation are highly consistent. The coefficients of the first term are all significantly positive. In contrast, the second secondary coefficients are all significantly negative, showing that the test results of the core explanatory variables are reliable.

Specifically, the first-order coefficient of environmental regulations is significantly positive, and the second-order coefficient is significantly negative. It shows that, from the provincial level, the impact of environmental regulations on China's OFDI is in an inverted "U" shape. In the initial stage, strengthening environmental regulations have promoted the increase of China's OFDI. However, when the environmental regulations are strengthened to a certain extent, environmental regulations will significantly inhibit the development of China's OFDI. Combined with theoretical analysis, this article believes that the possible reasons for the inverted "U"-shaped influence trend are as follows: first, in the initial stage, in the face of the increase in the intensity of environmental regulations, the technological upgrading effect and capital squeeze effect of enterprises are relatively small. The main problem it faces is the increase in production costs.

On the one hand, if companies continue to produce domestically, they will face increases in environmental compliance costs such as new clean production equipment, the payment of sewage charges, and pollution control costs. The company's profit will drop significantly, which motivates companies to transfer production across the country; on the other hand, to prevent a decline in profits, companies may seek international markets to expand sales. At this time, companies may choose to invest and build marketing subsidiaries overseas. Companies also increase the possibility of companies investing abroad. Second, in the intermediate stage, environmental regulations have been continuously strengthened.

On the one hand, the production cost faced by enterprises has further increased. On the other hand, enterprises' technology research and development has also been continuously enhanced. The new technology developed may reduce production costs to a certain extent (that is, the technology compensation effect plays a role). But at the same time, the capital squeeze effect caused by technology research and development is also increasing.

At this stage, foreign investment in enterprises is still on the rise, but the rising speed may gradually slow down. Third, in the later stage, the intensity of environmental regulations exceeded the inflection point, and the external direction began to show a downward trend. One possible explanation is that the company's capital crowding effect is too large at this time (long-term R&D investment leads to large R&D fixed capital; compared with other capitals, these capitals may be more inconvenient for cross-border flows) and even exceed the sum of production cost effects and technological innovation effects. Another possible explanation is that enterprises have gradually shifted from polluting to nonpolluting industries through long-term technological R&D and accumulation.

Next, briefly explain the impact of other control variables on China's OFDI. Among the four variables (GDPP, wage, energy, and research) that may be related to market seeking motivation, cost seeking motivation, resource seeking motivation, and strategic asset seeking motivation; only the coefficient of wage is significantly positive, which shows that domestic production costs have a positive effect. China's OFDI has a significant positive impact, which illustrates the existence of the cost-seeking motive of OFDI. It further illustrates that environmental regulations may impact OFDI by increasing production costs. The insignificant GDPP coefficient indicates that, from the home country's perspective, with the continuous improvement of domestic consumption power, the domestic market is still not saturated; the insignificant energy coefficient indicates that imports rather than OFDI may supplement the domestic resource demand gap. The research coefficient is insignificant, indicating that the improvement of domestic R&D level is not enough to impact OFDI. However, it also indicates that there may be strategic asset-seeking OFDI because with the continuous improvement of the domestic R&D level, enterprises will no longer aim to find strategic assets in the overseas market but turn to the domestic market. Other control variables are insignificant, indicating that human capital, the degree of domestic marketization, and the degree of trade dependence do not significantly impact OFDI. The significance of the control variable coefficients in this paper is consistent with the research [37].

5.3. Robustness Test. To further verify the reliability of the regression results, this section will carry out the corresponding robustness test.

5.3.1. Replace the Dependent Variable. As mentioned above, many scholars believe that stock data may better reflect the true situation of OFDI than flow data. Compared with flow data, stock quantity has stability advantages and small fluctuations. Therefore, this section will direct OFDI. The investment stock data are used as the dependent variable, and the same explanatory variable is regressed. The regression results are shown in the first column of Tables 4–6.

Table 5: Robustness test.

Variable	(1) Stock regression	(2) 2SLS regression	(3) Lag one-stage regression
ER	0.1061***	0.2938***	
	(0.009)	(0.001)	
ER2	−0.2241***	−0.5489***	
	(0.010)	(0.001)	
LER			0.1825*
			(0.060)
LER2			−0.3711*
			(0.055)
_cons	−3.945		−23.27
	(0.694)		(0.116)
Control variables	Control	Control	Control
Individual trends	Control	Control	Control
Time trend	Control	Control	Control
N	360	358	358
R^2	0.929	0.801	0.803

The results show that compared with the benchmark regression, when the stock of OFDI is taken as the dependent variable, the inverted U-shaped impact of environmental regulations on China's OFDI is more significant. The variable angle tests the robustness of the benchmark regression results.

5.3.2. Consideration of Endogenous Issues. To a certain extent, fixed effects regression solves the endogeneity problem caused by the omitted variables. However, considering there may be a two-way causal relationship between OFDI and environmental regulations, this article adopts two methods to avoid the endogeneity problem. Interference with unbiased estimates of empirical results:

(1) Concerning the research by [46–48], we use environmental regulation and the first-order lag of its square term as an instrumental variable and use the two-stage least squares method (2SLS) conducted empirical regression. The regression results are shown in the second column of Table 5. The regression results show that the estimated coefficients of environmental regulation's first and second terms are positive and negative, respectively, and are significant at the 1% level, consistent with the benchmark regression conclusion.

(2) When overcoming the endogenous problem, another common method is to treat the main variables as a one-period lag in the regression. This method is also adopted here. The regression results are shown in the third column of Table 5. The results show that, after the lagging one-stage treatment, the significance level of environmental regulations' primary and secondary terms has declined. They are still significant at the 10% significance level.

Based on the above tests, after replacing the dependent variables (OFDI stock), core explanatory variables (LER, LER2), and using the instrumental variable method for regression, the regression results of the core variable coefficients are consistent with the benchmark regression. Therefore, there are good reasons to believe that the benchmark regression results are robust. In addition, the inverted U-shaped inflection points are calculated according to the benchmark regression, and the three robustness tests are 0.2633, 0.2368, 0.2672, and 0.245, respectively. Comparing the environmental regulation intensity of China's provinces (regions, cities), most of them are on the left side of the inflection point.

Table 6: Regional heterogeneity test.

Variable	(1) East	(2) Middle	(3) West
ER	0.3281**	0.0559	0.2214**
	(0.043)	(0.523)	(0.041)
ER2	−0.6446	−0.1524	−0.2856*
	(0.106)	(0.460)	(0.085)
Control variables	Control	Control	Control
Individual trends	Control	Control	Control
Time trend	Control	Control	Control
N	132	96	130
R^2	0.851	0.862	0.835

5.4. Heterogeneity Test

5.4.1. Regional Heterogeneity Test. A subregional test will be conducted in this section to analyze regional heterogeneity in the impact of environmental regulations on China's OFDI. Specifically, the 30 provinces are divided into eastern regions, central regions, and western regions. The eastern regions include 11 provinces: Beijing (city), Hebei, Tianjin (city), Shanghai (city), Liaoning, Zhejiang, Jiangsu, Fujian, Shandong, Guangdong, and Hainan; the central region includes 8 provinces: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan; the western region includes 12 provinces: Neimenggu, Guangxi, Chongqing (city), Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang. The test results are shown in Table 6.

Table 7: Regulation type heterogeneity test.

Variable	(1) Government leading	(2) Market-leading	(3) The social public leading	(4) Regulation efficiency leading
GovER	0.0603			
	(0.557)			
GovER2	−0.3361			
	(0.387)			
MarER		0.1983**		
		(0.023)		
MarER2		−0.5629**		
		(0.046)		
SocER			0.1493	
			(0.374)	
SocER2			−0.8926	
			(0.204)	
EffER				−2.109
				(0.874)
EffER2				217.44
				(0.784)
_cons	−33.23	−27.37	−26.72	−31.50
	(0.111)	(0.151)	(0.140)	(0.140)
Control variables	Control	Control	Control	Control
Individual trends	Control	Control	Control	Control
Time trend	Control	Control	Control	Control
N	358	358	358	358
R^2	0.795	0.803	0.798	0.795

According to Table 6, it can be seen that environmental regulations have obvious regional heterogeneity in China's OFDI. Specifically, in the eastern region, environmental regulations have a positive linear correlation with OFDI, that is, environmental regulations promote OFDI in the eastern region; in the central region, the primary and secondary coefficients of environmental regulations are not significant, indicating that environmental regulations in the central region have no significant effect on OFDI; in the western region, the relationship between environmental regulations and OFDI is still a significant inverted U-shaped relationship, but the turning point is relatively large. This article believes that this regional heterogeneity is mainly due to the following two reasons: first, according to the calculation results in Section 3.3, we can know that, on the whole, the intensity of environmental regulations in the eastern, central, and western regions, it is ER _(east) > ER _(center) > ER _(west). Therefore, when the intensity of environmental regulations in the eastern and central regions increases, and polluting industries or enterprises in these two regions can transfer to regions with weak environmental regulations and then move internationally while in the western region. In the face of increased environmental regulations, polluting industries or enterprises can only transfer internationally. Therefore, the regression coefficient of environmental regulations in the western region is significant; second, eastern enterprises can circumvent the intensity of environmental regulations through domestic transfer. However, the eastern region's technical level, human capital, and other resources are significantly higher than those in the central and western regions. It makes the technological innovation effect of environmental regulation very obvious in the eastern region, promoting the increase of OFDI activities in the eastern region. The regulatory "Porter hypothesis" may be valid. This article also confirmed the "Porter hypothesis" establishment in the subsequent analysis.

5.4.2. Heterogeneity Test of Regulatory Types. We divide government-led regulation (GovER), market-led regulation (MarER), and social. The historical scores of public-dominated regulation (SocER), regulatory efficiency (EffER), and their quadratic terms are used as independent variables and brought into the model for regression. The regression results are shown in Table 7.

According to Table 7, it can be seen that environmental regulations have obvious heterogeneity in the types of regulations on China's OFDI, and different types of regulations have significantly different effects on foreign direct investment. Specifically, except for market-led regulation (MarER), which has a significant impact on OFDI, government-led regulation (GovER) and public-led regulation (SocER) have no significant impact on OFDI, and regulatory efficiency has no significant impact on OFDI. The impact of OFDI is also not significant, which shows that market-based environmental regulations mainly cause the impact of environmental regulations on China's OFDI. The possible explanation is that although government-led regulation is the main force of China's environmental regulation; the means of government-led regulation is to promulgate new environmental protection laws and regulations, increase environmental protection supervisors, and increase

Table 8: The impact of environmental regulation on the technological innovation.

Variable	Whole (1) OFDI	Whole (2) Patent	East (3) Patent	Middle (4) Patent	West (5) Patent
Patent	0.543**				
	(0.037)				
LER		−1.003***	−1.712**	0.128	−0.353
		(0.007)	(0.044)	(0.544)	(0.161)
LER2		1.902***	3.348**	−0.284	0.525
		(0.007)	(0.031)	(0.575)	(0.284)
_cons	5.420	−0.265*	−0.568	−0.307	−0.0191
	(0.184)	(0.059)	(0.158)	(0.188)	(0.512)
Control variables	Control	Control	Control	Control	Control
Individual trends	Control	Control	Control	Control	Control
Time trend	Control	Control	Control	Control	Control
N	360	360	132	96	132
R^2	0.583	0.582	0.675	0.735	0.689

postmortem penalties for illegal enterprises. These measures usually cannot be directly related to the interests (or profits) of the enterprise, so the enterprise may not be sensitive to such regulations; the means of market-led regulation are often directly the collection of pollution fees or clean production subsidies, which are directly related to the interests (or profits) of the enterprise. Therefore, enterprises are more sensitive to such regulations. However, the public-led regulations are getting stronger, and they are not very sensitive to such regulations due to their nonmandatory nature. The insignificant results of the regression of regulatory efficiency may be that there is no obvious economic relationship between the final pollutant emissions and OFDI.

5.5. Existence Test of the Porter Hypothesis. The above research found that environmental regulations have significantly affected China's OFDI. Many studies have shown that the improvement of technological innovation or productivity of domestic enterprises is one of the prerequisites for enterprises to make direct foreign [49, 50] investments. Do environmental regulations affect the level of technological innovation in various provinces? Does the "Porter hypothesis" exist at the provincial level? Next, this article will analyze technological innovation and the mechanism of environmental regulations affecting OFDI.

There are many domestic studies on the "Porter hypothesis," but the research conclusions are inconsistent. Many studies support the establishment of the [51, 52] "Porter hypothesis." Some scholars have found that environmental regulations cannot improve domestic technological innovation [53, 54]. Regardless of the conclusion, the research idea is mainly to investigate the relationship between pollution control investment and research and development of new technologies. Generally speaking, to meet the requirements of government environmental regulations, companies usually adopt the following two strategies: one is to increase the cost of environmental compliance, which is not conducive to technological innovation in the long run; the other is to increase investment in new technology research and development. Efforts are taken to improve the output level or clean production technology and achieve the technology compensation effect. Next, this article draws on the research of [55], using the number of patents granted by each province (region and city) each year as a proxy variable for technological innovation to test whether they are affected by environmental regulations while taking into account environmental regulation affects the time lag of technological innovation. Here, the one-phase lag of environmental regulation is taken as the core explanatory variable. The test results are shown in Table 8.

According to Table 8, technological innovation has promoted the development of China's OFDI (column 1 of Table 8), and the relationship between environmental regulation and technological innovation shows a significant U-shape. As the intensity of environmental regulation increases, the technological level shows a trend of the first decline and then rising, which is in line with the "Porter hypothesis" content. When the government's environmental regulations are weak, companies will usually transfer part of their profits or R&D expenditure budgets to pay for environmental compliance costs in the short term due to optimal production considerations, thereby reducing the current corporate R&D efforts, that is, environmental regulations. It is not conducive to technological innovation and promotion in the short term. From a long-term perspective, to get rid of this passive end-of-pipe governance method and reduce environmental compliance costs, companies usually have two strategies: first, the company chooses to increase innovation in cleaner production technology to green the actual production process. Innovation—the second is to obtain cleaner production technology from the outside through market means to improve its technical level directly. Either way, the goal of the enterprise is the same: to offset the rising cost of environmental compliance through the compensation effect of technological innovation.

At the same time, it is found that there are regional differences in the "Porter hypothesis." Developed provinces such as eastern China support the establishment of the "Porter hypothesis," while the underdeveloped provinces in the central and western regions do not support the "Porter hypothesis." It positively explains the significant promotion of OFDI by environmental regulations in the central and eastern regions. The role is that, under the continuous strengthening of environmental regulations, technological innovation in the eastern region is sufficient to offset the effect of domestic transfer of industries or enterprises, thus positively impacting OFDI.

6. Conclusions and Enlightenments

We empirically studied the impact of environmental regulations on China's OFDI from the provincial level and reached the following main conclusions: (1) as a whole, the impact of environmental regulations on the OFDI of China's provinces shows a significant inverted U-shaped relationship. The investment volume showed an upward trend and then a downward trend. (2) Environmental regulation has a significant regional heterogeneity on the impact of OFDI in each province (regions and cities) has a significant role in promoting the OFDI behavior of eastern and western provinces (regions and cities), but has no significant impact on the OFDI behavior of central provinces (regions and cities). (3) Different types of environmental regulations have different impacts on OFDI. Market-led environmental regulations significantly impact China's OFDI, while government-led and public-led environmental regulations have no significant impact on OFDI. (4) Fourth, there is a technological innovation effect in the influence path of environmental regulations on OFDI of various provinces (regions and cities), that is, the effect of "Porter hypothesis," but the effect of technological innovation is mainly reflected in the eastern provinces (regions and cities) and central and western regions. The effects of technological innovation in provinces are not yet obvious.

This study has the following enlightenment:

On the one hand, we should scientifically enhance the intensity of China's environmental regulation, give full play to the technological innovation effect of environmental regulation, and promote domestic enterprises to go global with high quality. Due to the weak intensity of environmental regulation in the central and western regions, the critical value of the technological innovation effect has not been reached, and the environmental regulation in the central and western regions has gradually increased.

On the other hand, taking a market-leading environmental regulation as the breakthrough point improves China's diversified environmental regulation system so that various environmental regulation tools can promote foreign investment. Continue strengthening the role of market-leading environmental regulation and innovative regulatory means, such as expanding the scope of carbon-emissions-trading pilot projects and strengthening green subsidies. At the same time, we should strengthen the call for the public to participate in environmental governance and let the public change from "passive participation in governance" to "active participation in governance."

The enlightenment of this paper can enable environmental regulation and OFDI to fully play the role of building a bridge between a new pattern of comprehensive opening up and high-level environmental protection and make due contributions to the implementation of the new development concept of "innovation, coordination, green, open, and sharing."

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

All authors contributed to the study's conception and design. Xiaoyong Li and Caiyi Liang performed material preparation, data collection, and analysis. Xiaoyong Li wrote the first draft of the manuscript, and all authors commented on previous versions. All authors read and approved the final manuscript.

Acknowledgments

This work was supported by the major project of National Social Science Foundation of China "Research on China's international investment history" (19ZDA059) and Key Projects of Social Science Planning in Jingdezhen City, "research on precise investment promotion strategy of Jingdezhen ceramic industry from the perspective of industrial chain" (730/04103).

References

[1] L. Guo, J. Lu, and S. Guo, *Review and Prospect of China's Foreign Direct Investment in the Past 40 Years of Reform and Opening up Asia-pacific Economic Review*, pp. 111–121+152, Australian National University, Canberra, Australia, 2018.

[2] E. Helpman, M. J. Melitz, and S. R. Yeaple, "Export versus FDI with heterogeneous firms," *The American Economic Review*, vol. 94, no. 1, pp. 300–316, 2004.

[3] I. Walter and J. L. Ugelow, "Environmental policies in developing countries ambio," *Scientific Research (New York)*, vol. 8, pp. 102–109, 1979.

[4] A. Mody, S. Roy, D. Wheeler, and S. Dasgupta, "Environmental regulation and development : a cross-country empirical analysis," *Oxford Development Studies*, 1995.

[5] A. Bitat, "Environmental regulation and eco-innovation: the Porter hypothesis refined," *Eurasian Business Review*, vol. 8, no. 3, pp. 299–321, 2018.

[6] C. Wang, J. Wu, and B. Zhang, "Environmental regulation, emissions and productivity: evidence from Chinese COD-emitting manufacturers," *Journal of Environmental Economics and Management*, vol. 92, pp. 54–73, 2018.

[7] Y. Zhou, J. Jiang, B. Ye, and B. Hou, "Green spillovers of outward foreign direct investment on home countries: evidence from China's province-level data," *Journal of Cleaner Production*, vol. 215, pp. 829–844, 2019.

[8] A. Levinson, "Environmental regulations and manufacturers' location choices: evidence from the Census of Manufactures," *Journal of Public Economics*, vol. 62, no. 1-2, pp. 5–29, 1996.

[9] Y. Ménière, A. Dechezleprêtre, M. Glachant, and I. Hascic, "Invention and transfer of climate change mitigation

technologies: a study drawing on patent data," *Review of Environmental Economics and Policy*, vol. 5, pp. 109–130, 2011.

[10] D. V. Aiken, R. Färe, S. Grosskopf, and C. A. Pasurka, "Pollution abatement and productivity growth: evidence from Germany, Japan, The Netherlands, and the United States," *Environmental and Resource Economics*, vol. 44, no. 1, pp. 11–28, 2009.

[11] W. Jing and L. Zhang, "Environmental regulation, opening to the outside world and Green Technology progress in Chinese industry," *Economic Research Journal*, vol. 49, pp. 34–47, 2014.

[12] A. Levinson and M. S. Taylor, "Unmasking the pollution haven effect," *International Economic Review*, vol. 49, no. 1, pp. 223–254, 2008.

[13] M. A. Cole, R. J. R. Elliott, and S. Wu, "Industrial activity and the environment in China: an industry-level analysis China Economic Review," *China Economic Review*, vol. 19, pp. 393–408, 2008.

[14] J. Guo, "The Impact of environmental regulation on green technology innovation: evidence of "Porter Effect"," *China Finance & Trade Economics*, vol. 40, pp. 147–160, 2019.

[15] H. Li and Q. Zhou, "Environmental regulation, resource endowment and urban industrial transformation: a comparative analysis of resource-based cities and non-resource-based cities," *Economic Research Journal*, vol. 53, pp. 182–198, 2018.

[16] L. Dam and B. Scholtens, "The curse of the haven: the impact of multinational enterprise on environmental regulation Ecological Economics," *Ecological Economics*, vol. 78, pp. 148–156, 2012.

[17] Y. Wang, X. Sun, and X. Guo, "Environmental regulation and green productivity growth: empirical evidence on the Porter Hypothesis from OECD industrial sectors," *Energy Policy*, vol. 132, pp. 611–619, 2019.

[18] J. Chen, X. Wang, W. Shen, Y. Tan, L. M. Matac, and S. Samad, "Environmental uncertainty, environmental regulation and enterprises' green technological innovation," *International Journal of Environmental Research and Public Health*, vol. 19, no. 16, pp. 9781–9828, 2022.

[19] D. K. Kellenberg, "An empirical investigation of the pollution haven effect with strategic environment and trade policy," *Journal of International Economics*, vol. 78, no. 2, pp. 242–255, 2009.

[20] X. Cai, Y. Lu, M. Wu, and L. Yu, "Does environmental regulation drive away inbound foreign direct investment?" *Journal of Development Economics*, vol. 123, pp. 73–85, 2016.

[21] S. Chung, "Environmental regulation and foreign direct investment: evidence from South Korea," *Journal of Development Economics*, vol. 108, pp. 222–236, 2014.

[22] J. Lan, M. Kakinaka, and X. Huang, "Foreign direct investment, human capital and environmental pollution in China," *Environmental and Resource Economics*, vol. 51, no. 2, pp. 255–275, 2012.

[23] A. Waldkirch and M. Gopinath, "Pollution control and foreign direct investment in Mexico: an industry-level analysis," *Environmental and Resource Economics*, vol. 41, no. 3, pp. 289–313, 2008.

[24] J. M. Dean, M. E. Lovely, and H. Wang, "Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China," *Journal of Development Economics*, vol. 90, pp. 1–13, 2009.

[25] V. Kathuria, "Does environmental governance matter for foreign direct investment?" *Asian Development Review*, vol. 35, no. 1, pp. 81–107, 2018.

[26] D. Sheng and G. Zhang, "Environmental regulation and enterprise total factor productivity growth in dual-control area Management World," *Journal of Cleaner Production*, vol. 35, pp. 24–42+198, 2019.

[27] J. Weiss, A. Stephan, and T. Anisimova, "Well-designed environmental regulation and firm performance: Swedish evidence on the Porter hypothesis and the effect of regulatory time strategies," *Journal of Environmental Planning and Management*, vol. 62, no. 2, pp. 342–363, 2019.

[28] X. Nie, J. Wu, H. Wang et al., "Booster or stumbling block? the role of environmental regulation in the coupling path of regional innovation under the porter hypothesis," *Sustainability*, vol. 14, no. 5, 2876 pages, 2022.

[29] R. A. Becker, "Local environmental regulation and plant-level productivity," *Ecological Economics*, vol. 70, no. 12, pp. 2516–2522, 2011.

[30] M. Spatareanu, "Searching for pollution havens: the impact of environmental regulations on foreign direct investment," *The Journal of Environment & Development*, vol. 16, no. 2, pp. 161–182, 2007.

[31] R. J. R. Elliott and K. Shimamoto, "Are ASEAN countries havens for Japanese pollution and governance transformation on thmy," *University of Birmingham*, vol. 31, pp. 236–254, 2008.

[32] R. Kneller and E. Manderson, "Environmental regulations and innovation activity in UK manufacturing industries," *Resource and Energy Economics*, vol. 34, no. 2, pp. 211–235, 2012.

[33] W. Cai and Q. Li, "Research on the dual impact of environmental regulation on enterprise's eco technological innovation," *Scientific research management*, vol. 10, pp. 87–95, 2019.

[34] F. Filippaios, M. Papanastassiou, and R. Pearce, "The evolution of US outward foreign direct investment in the pacific rim: a cross-time and country analysis," *Applied Economics*, vol. 35, no. 16, pp. 1779–1787, 2003.

[35] H. Yang, Q. Meng, J. Wang, and H. Li, *The Impact of Bilateral Investment Treaties on China's OFDI: An Investment Treaty Heterogeneity Perspective Management World*, pp. 24–36, 2016.

[36] M. Busse and C. Hefeker, "Political risk, institutions and foreign direct investment," *European Journal of Political Economy*, vol. 23, no. 2, pp. 397–415, 2007.

[37] P. Chen, G. Xian, and L. Ma, *Institutional Environment and China's OFDI: An Analytical Perspective Based on Extended Margin World Economy Studies*, pp. 50–61+136, 2017.

[38] P. J. Buckley, L. J. Clegg, A. R. Cross, X. Liu, H. Voss, and P. Zheng, "The determinants of Chinese outward foreign direct investment," *Journal of International Business Studies*, vol. 38, no. 4, pp. 499–518, 2007.

[39] Q. Liu, P. Tao, and J. Hong, "Research on the motivation of China's overseas M&A -- Based on the perspective of extensive margin and intensive margin," *Economic Research Journal*, vol. 52, pp. 28–43, 2017.

[40] J. Huang and A. Zhang, "An empirical study on the Main Drivers of China's OFDI -- Based on the analysis of outward investment flows from 1982 to 2007," *International Economics and Trade Research*, vol. 25, pp. 4–10, 2009.

[41] L. L. Zhang, Z. G. Zhao, C. Y. Niu, and J. Zhang, "Regional equilibrium and Motivation difference of China's OFDI: an

empirical analysis based on provincial panel data," *Journal of Business Economics*, vol. 27, no. 1, pp. 75–80, 2011.

[42] X. Cui, J. Li, and G. Xian, *Whether "bringing in" Promotes "going Out" -- A Study Based on Inter-provincial Data Inquiry into Economic Issues*, pp. 137–144, 2018.

[43] B. A. Blonigen, "In search of substitution between foreign production and exports Journal of International Economics," *Journal of International Economics*, vol. 53, pp. 81–104, 2001.

[44] Q. Mao and J. Xu, "Whether Chinese enterprises' OFDI promotes enterprise innovation," *The Journal of World Economy*, vol. 37, pp. 98–125, 2014.

[45] D. L. Swenson, "Foreign investment and the mediation of trade flows," *Review of International Economics*, vol. 12, pp. 609–629, 2004.

[46] L. Du, Y. Zhao, K. Tao, and W. Lin, "The compound effect of environmental regulation and governance transformation on the improvement of green competitiveness: empirical evidence from Chinese industry," *Economic Research Journal*, pp. 106–120, 2019.

[47] X. Li, X. Lu, and X. Tao, "Whether the intensity of environmental regulation affects the trade comparative advantage of China's industrial sectors," *The Journal of World Economy*, vol. 35, pp. 62–78, 2012.

[48] J. Wang and B. Liu, *Environmental Regulation and Firm Total Factor Productivity: Empirical Analysis Based on Data of Chinese Industrial Firms China Industrial Economics*, pp. 44–56, 2014.

[49] G. Jiang, "Firm heterogeneity and foreign direct investment: evidence from Chinese firms," *Journal of Financial Research*, pp. 81–96, 2015.

[50] W. Tian and M. Yu, "Firm productivity and "going out" OFDI: an empirical study based on firm-level data China," *Economic Quarterly*, vol. 11, pp. 383–408, 2012.

[51] G. Jin and K. Shen, "Beggar-thy-neighbour or partner? -- Interaction between environmental regulation enforcement and urban productivity growth," *Management World*, vol. 34, pp. 43–55, 2018.

[52] Y. Yuan, Y. Miao, and R. Xie, "Empirical analysis of environmental regulation performance and its influencing factors," *Journal of Industrial Technological Economics*, vol. 35, pp. 92–97, 2016.

[53] Y. He and Q. Luo, "Environmental regulation, technological innovation and Industrial total factor Productivity: a retest of "Strong Porter hypothesis"," *Soft Science*, vol. 32, pp. 20–25, 2018.

[54] Z. Tu and R. Chen, "Can the emission trading system achieve the porter effect in China?" *Economic Research Journal*, vol. 50, pp. 160–173, 2015.

[55] N. Shen and F. Liu, "Can high-intensity environmental regulation really promote technological innovation? -- Retest based on," *"Porter hypothesis" China Soft Science*, pp. 49–59, 2012.