Research on the Industrial Structure Effect of China's OFDI

Zhaohua Zhang[a], Ziyue Wang*

marinazzh@126.com[a], Wangziyue001017@163.com*

School of Economics and Management, Beijing Jiaotong University, Beijing, China

Abstract: Using provincial panel data from 2013 to 2021 and fixed-effect method to study the effect and heterogeneity of OFDI on industrial structure optimization in China under environmental regulation. The results show that China's OFDI hinders the adjustment of industrial structure to some extent. Under the regulatory effect of environmental regulation, the inhibitory effect of OFDI on the upgrading of industrial structure is significantly weakened, and the regulatory effect has regional heterogeneity and economic development level heterogeneity.

Key words: Outward foreign direct investment; Environmental regulation; Industrial structure optimization.

1 Introduction

Over the past 40 years since the reform and opening up, China has experienced the transformation from actively attracting foreign capital to emphasizing both domestic capital going out and foreign investment coming in. Outward Foreign Direct Investment (OFDI) plays an increasingly important role in promoting national economic development. With the rapid increase in the amount of outward foreign direct investment, the quality of investment has also been optimized, and the investment structure has tended to be more balanced and diversified from being dominated by the manufacturing and mining industries, which provides a new opportunity and direction for the adjustment and optimization of China's industrial structure. At present, China's ecological civilization construction has entered a critical period. As the key to achieving high-quality development and comprehensive transformation of green economy, accelerating the transformation of industrial structure can take advantage of the OFDI "external seeking" path, integrating domestic and foreign resources to obtain the reverse green technology spillover, and help "internal development". The goal of exploring the specific impact of OFDI on China's industrial optimization and upgrading can provide a reference for the formulation of OFDI policies to promote industrial optimization.

There are two views on the impact of OFDI on industrial restructuring. One is the "promotion theory" (Vernon, 1966[1]; Bu and Yi, 2015[2]; Zhu and Li, 2022[3]); the other is the "inhibition theory", which stems from the hollowing out of the home country industry (Ng, 1995)[4]; Cost bottom-up and capital crowding out (Liu and Nie, 2015)[5], the mismatch between economic structure and OFDI industrial structure (Fan and Wang , 2006)[6], and the imbalance of inter-regional development levels (Wang and Kan, 2013)[7].

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According to Porter's hypothesis, reasonable environmental regulation is a powerful tool to promote technological innovation and generating "innovation compensation" effect. On the contrary, environmental regulations are believed to squeeze out corporate profits due to higher production costs (Conrad and Wastl, 1995[8]; Popp et al. 2010[9]).

The marginal contributions of this paper are as follows: (1) Environmental regulation is added to the model of OFDI on industrial structure adjustment, enriching the research on the role of OFDI on industrial structure optimization from the perspective of environmental regulation; (2) Dividing the research object according to the level of economic development on the basis of regional heterogeneity, and adding the analysis of heterogeneity in the level of development, which provides a theoretical basis for the government to flexibly use environmental protection policy tools and implement the principle of adapting environmental regulations to local conditions.

The rest of the paper are that: The second part analyzes the theoretical mechanism and proposes hypotheses; the third part selects the relevant variables and builds the model. The fourth part conducts an empirical analysis; the fifth part puts forward countermeasures and suggestions according to the conclusion.

2 Theoretical analysis and research hypothesis

2.1 Impact of OFDI on industrial structure optimization

As an important channel of international capital and technology spillover, OFDI is crucial to the economic and social development of a country or region, in which the industrial structure plays an important role. There are two major mechanisms, positive and negative, in driving the optimization effect of industrial structure.

On the one hand, OFDI with different motivations produces three types of optimization effects: industrial transfer, technological progress, and key resource supplementation (see Figure 1).

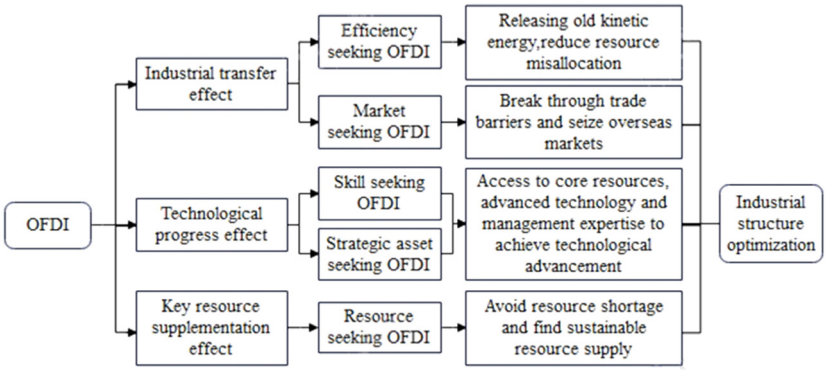

Fig. 1. Theoretical mechanism of OFDI's positive effect on industrial structure optimization

On the other hand, China's OFDI presents a "dual path" of parallel: "down-gradient" investment to lower-degree developing countries and "counter-gradient" investment to higher-degree developed countries, with obvious color of developing countries, which

hindering the optimization of industrial structure (see Figure 2).

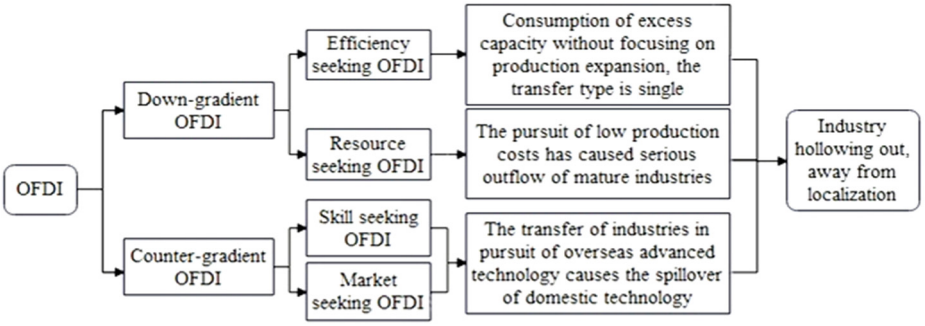

Fig. 2. Theoretical mechanism of OFDI's negative influence on industrial structure optimization

As a result, the following theoretical hypotheses are proposed in this pacounter-gradientper.

H1a: OFDI can contribute to the optimization of industrial structure;

H1b: OFDI can act as an impediment to industrial structure optimization.

2.2 The Role Mechanism of Environmental Regulation on OFDI Influencing Industrial Structure Upgrading

According to neoclassical theory and Porter's Hypothesis, formal environmental regulation plays a direct role in the process of industrial structure restructuring, mainly through the negative "cost effect" and positive "innovation compensation effect". "Cost effect" believes that formal environmental regulations will cause unexpected, non-operational costs and lead to price increases, resulting in the loss of a large number of markets for products, which will have adverse impact on the adjustment of production structure of enterprises and even the whole society. However, from the perspective of Porter's hypothesis, the impetus brought by formal environmental regulation on enterprises far exceeds its unexpected cost, and this positive mechanism can encourage enterprises to create greater benefits to fill the cost of production, which is conducive to the upgrading of industrial structure (Porter, 1991)[10].When the "compensation for innovation" effect of environmental regulations exceeds the "cost of compliance" effect, firms can overcome the negative impacts of environmental regulations and transform and upgrade in the way of green technological innovations.

Nowaday, by vigorously implementing environmental regulations, China can form a good industrial cluster with high technology and light pollution, and further enhance the efficiency of industrial green economy. However, going too far is not enough. Too much intensity in the implementation of environmental regulation will hit the enthusiasm of enterprise creation, inhibit the reverse technology spillover of enterprise outward direct investment, and hinder the process of upgrading its industrial structure (Zhang, 2019)[11].

Based on the above analysis, the following hypotheses are proposed.

H2a: Under the influence of environmental regulations, OFDI has a more obvious promoting effect on the upgrading of industrial structure;

H2b: Under the influence of environmental regulations, the promotion effect of OFDI on industrial structure upgrading is weakened.

3 Study design

3.1 Selection of variables

(1) Explained variable: Industrial Structure Upgrading Index (lnind). This paper takes the measurement method of industrial structure proposed by Liu et al (2008)[12] as the main reference, and takes the product of output ratio of each industrial sector and labor productivity as the measurement standard of industrial structure upgrading. At the same time, referring to Li Fengchun's (2012)[13] approach, labor productivity is derived to reduce the disturbance of different productivity difference indices.

(2)Core explanatory variable: Foreign direct investment (lnOFDI). The outward foreign direct investment of the country and each province in the past ten years is selected with reference to the Statistical Bulletin of China's Outward Foreign Direct Investment. In order to reduce or even avoid the interference that may be caused by the volatility of flow data on the results, the core explanatory variable is adopted non-financial OFDI stock data in the communique, and the variable is represented by lnODFI.

(3) Moderating variable: Environmental Regulation (lneri). Referring to the measurement method proposed by Yuan and Xie (2014)[14], this paper takes environmental regulation intensity as the main target layer, SO2 and the removal rate of industrial smoke (powder) dust are taken as the evaluation index layer, and measurement of a composite index of formal environmental regulation by means of the index composite method and the weighted linear sum method.

(4) Control variables: with reference to Song and Han (2021)[15], Xie et al. (2022)[16], economic development level (lnGDP), technological innovation input (lnT_obv), foreign direct investment (IFDI) and degree of opening to the outside world (open) are selected as control variables.

3.2 Modeling

Firstly, a baseline panel model is constructed without considering the regulatory effects of environmental regulations, as shown in formula (1).

$$\ln ind_{ij} = \beta_0 + \beta_1 \ln OFDI_{ij} + \beta_2 \ln GDP_{ij} + \beta_3 \ln T\_obv_{ij} + \beta_4 \ln IFDI_{ij} + \beta_5 \ln open_{ij} + u_{ij} + \varepsilon_{ij} \quad (1)$$

In formula (1), the$\ln ind_{ij}$represents the industrial structure upgrading index of province i in year j; $\ln OFDI_{ij}$ means the level of OFDI carried out by province i in year j; $\ln GDP_{ij}$ represents the GDP development level of province i in year j; $\ln T\_obv_{ij}$ stands for the scientific and technological innovation level of province i in year j; $\ln IFDI_{ij}$ denotes the level of foreign direct investment made by province i in year j; $\ln open_{ij}$ denotes the degree of opening up of province i in year j; u_{ij} is an individual fixed effect; ε_{ij} represents the randomized perturbation term, and ε_{ij}~ iid (0, σ 2), i = 1,2,... , 29; j stands for

time; $\beta_0 \sim \beta_5$ are to be estimated coefficients.

In order to further verify the regulatory effect of environmental regulations on OFDI's effect on industrial structure upgrading, *this* paper introduced the formal environmental regulation intensity index (lneri) and the interaction term between formal environmental regulations and core explanatory variables (eri*lnOFDI) into the original model 1 to construct the regulatory effect model of environmental regulations, see Equation (4).

$$\ln ind_{it} = \beta_0 + \beta_1 \ln OFDI_{it} + \beta_2 \ln GDP_{it} + \beta_3 \ln T\_obv_{it} + \beta_4 \ln IFDI_{it} + \beta_5 \ln open_{it} + \beta_6 \ln eri_{it} + \beta_7 eri_{it} * \ln OFDI_{it} + u_{it} + \varepsilon_{it} \quad (2)$$

In formula (2), theβ_6 andβ_7 are parameters to be estimated respectively for intensity index of formal environmental regulations and the interaction term between formal environmental regulations and OFDI, and the rest of the notations are consistent with the above.

3.3 Data sources and processing

This paper selected the national aggregate data and the provincial panel data of 29 provinces, municipalities and autonomous regions from 2013 to 2021. The original data required are all from the official website of the National Bureau of Statistics, the official website of the provincial statistical bureaus and the EPS database of China Statistical Yearbook, China Environmental Statistical Yearbook, China Urban Statistical Yearbook, China Outward Investment Statistical Bulletin, and provincial statistical yearbook of each province in previous years. In order to enhance the credibility and accuracy of the estimation, the data involving US dollars are converted by using the current US dollar exchange rate period of the year. There are some missing data in the calculation, and the data are made up through the exponential smoothing method. In order to make the data distribution more uniform, logarithmic processing is carried out for each variable. At the same time, to increase the stability of the data, the practice of shrinking the tails and eliminating the outliers is carried out.

4 Results and analysis

4.1 Benchmark regression

Calculate the correlation matrix of the variables, the results are shown in Table 1. Explanatory variables and explanatory variables are significantly positively correlated[1]. The correlation coefficient is 0.229. The correlation between the main explanatory variable and control variables isn't high except for some correlations are slightly higher than 0.7, and the other correlation degrees are not high, indicating that the correlation between the two is not strong. At the same time, except for a few cases, the variables are significant at the 1% level. What's more, in order to ensure the effectiveness and accuracy of the regression results, a

[1] The explanatory variables and explained variables have opposite coefficient signs in correlation analysis and baseline regression analysis. According to Woodridge's Econometrics, correlation analysis only considers the relationship between two single variables, and does not consider other factors that may affect the result; regression analysis takes other variables into account and analyzes the relationship between the explanatory variable and the explained variable under their influence. Therefore, it is normal for opposite results to occur.

multicollinearity test was conducted on the model before it, and results showed that there was no multicollinearity problem between variables, so the regression analysis could be performed.

Table 1. Variable correlation results

	lnind	lnOFDI	lnGDP	lnT obv	lnIFDI	lnopen	VIF
lnind	1						
lnOFDI	0.229***	1					2.65
lnGDP	0.462***	0.727***	1				3.38
lnT obv	0.219***	0.647***	0.704***	1			2.19
lnIFDI	0.117*	0.585***	0.672***	0.438***	1		1.96
lnopen	-0.102	0.420***	0.260***	0.269***	0.308***	1	1.24

Note: *** p<0.01, ** p<0.05, * p<0.1 (the same below).

The OLS model, fixed-effects model of control province and time are used to explore how OFDI and other control variables affect the adjustment of industrial structure, results are shown in Table 2. Through the analysis of regression results, it can be seen that under the conditions of controlling time and provinces, the coefficient of lnOFDI in the model is significantly negative[1]. It shows that OFDI is negatively correlated with the upgrading of domestic industrial structure, which is in line with the theoretical analysis of the negative effect and correlation hypothesis. Thus hypothesis H1b can be proved.

Table 2. Linear regression results

VARIABLES	lnind	VARIABLES	lnind
lnOFDI	-0.0288*	lnT_obv	-0.00972
	(0.0164)		(0.00809)
lnIFDI	-0.0246***	Constant	1.553***
	(0.00564)		(0.564)
lnopen	-0.00950	Year	Yes
	(0.0182)	Province	Yes
lnGDP	0.551***	Observations	261
	(0.0623)	R-squared	0.866

Note: Standard errors in parentheses (the same below).

4.2 Robustness Tests and Endogeneity Issues

The explanatory variables are treated with first-order lag, and the industrial structure upgrading coefficient in the current period is regression, and the results are still robust[2].

The first-order lag term of the core explanatory variable lnOFDIt-1 is chosen as the instrumental variable, and three methods of "unidentifiable test", "weak instrumental variable test" and "endogenous test" are used to test the instrumental variable. The results show that the

[1] Same footnote as previous page.

[2] Limited to space, the results remain available. The same below.

instrumental variable is feasible and effective. After that, the two-stage least square method and generalized of moments estimation method (GMM) find that China's OFDI has a certain impediment effect on industrial restructuring, indicating that the result was robust.

4.3 Moderating effects of environmental regulation

Through the interaction effect method, the adjustment effect of variables is verified. The study finds that: the regression coefficient of explanatory variables are smaller than the baseline regression, and the regression coefficient of the interaction term of formal environmental regulation eri and OFDI is significantly positive at the level of 5%. It indicates that the interaction between formal environmental regulation and outward foreign direct investment suppresses the negative impact on industrial restructuring as mentioned above. H2a is verified.

4.4 Heterogeneity test

(1) Regional heterogeneity. Dividing the country into “eastern” and “mid-west regions”, find that under the influence of environmental regulation, OFDI in eastern region has no obvious effect on the improvement of industrial structure. In contrast, the situation in the mid-west has seen significant improvement. This indicates that there’s heterogeneity in the regulatory effect of environmental regulation on the optimization of industrial structure influenced by OFDI.

(2) Heterogeneity of economic development level. By taking the average annual GDP, 29 provinces’ and cities’ economic development level is divided into two groups: above and below the mean levels. The results show that OFDI with higher economic development level has a positive effect on industrial structure upgrading, but the coefficient is insignificant, and the interaction coefficient between environmental regulation index and explanatory variables is negative. The lower level of economic development is consistent with the above set of results. The heterogeneity of environmental regulation is verified again.

5 Conclusions

This paper analyzes the role of OFDI in the optimization of industrial structure under environmental regulation, puts forward a hypothesis through the analysis and research of theoretical mechanism, and establishes panel model and regulatory effect model by using the data of various provinces and cities in China in the past decade, and further studies the correlation between the three. The main conclusions are as follows: Overall, the current OFDI in China does not optimize the industrial layout and structure very well; under the regulatory effect of environmental regulation, OFDI's promoting effect on the upgrading of industrial structure is obviously enhanced. To be specific, the above influence mechanism is established in different divisions and regions with low economic development degree, while he opposite effect is shown in regions with high economic development level, that is, the effect of environmental policy on the optimization of industrial structure of China's OFDI has regional heterogeneity and economic development level heterogeneity.

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