The Effect of Environmental Regulations on Economic Development and Industrial Structure

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Abstract: China's economy has marched onto a new track of development. It is characterized by transforming the extensive development mode of large resource consumption and large pollution emission to the green development mode of resource and environmental protection. This paper, from the perspectives of per capita GDP, unit GDP energy consumption and pollutant emissions, Gini coefficient, economic growth volatility and urban registered unemployment rate, uses the principal component analysis method to build comprehensive economic development indicators. By using China 2000-2018 Provincial Panel Data, it aims to conduct an empirical examination which shows that the quality of economic development is greatly affected by environmental regulations through the transmission mechanism of industrial structure, industrial transfer and new industrial development. Environmental regulations also stimulate technological innovations, substitute traditional industries with new ones, upgrade industrial structure through innovations, and speed up high-quality economic development. Industrial transfer and transformation greatly cut off the cost of the enterprises, which reflects obvious economic effect. Therefore, environmental regulations should become the impetus to the transforming and upgrading of polluting industries, strengthening the constraints of environmental regulations, improving the efficient employment of resources and reducing environmental pollutions, so as to keep to the road of a faster and greener economic development.

Key words: environmental regulation; industrial transfer; industrial transformation; economic development

1 Introduction

Since the inauguration of reform and open-door policy in 1978, China's economy has entered a fast development lane, making China the second largest economy in the world. However, with the rapid economic development, environmental pollution has become an increasingly serious problem afflicting our people. In the 2018 International Ranking of Environmental and Economic Performance, China's per capita GDP pollutant emissions ranked 120th, somewhere in the middle and lower positions. Since 2017, ecological progress has acquired a prominent position. The Proposal of the CPC Central Committee on Formulating the 13th Five-Year Plan for National Economic and Social Development specifically highlights the development concept of green economy and obtains new economic growth points from the perspective of environmental protection. Therefore, economic development and environmental protection have become the most important problems to address in the new era of high-quality development. The existing foreign and domestic research efforts mainly focus on the effect of

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environmental regulation and economic development on the economic aggregate. In fact, economic growth is a multi-dimensional concept, which does not only represent the increase of economic aggregate, but more importantly, the quality of growth. With the employment of the concept of economic development, this to describe the high-quality economic growth, which includes the improvement of industrial structure, living environment and other aspects. As a result, it can more comprehensively reflect the quality of the economy.

Environmental regulation is the government behavior of addressing environmental pollution issue, and industrial structure upgrading refers to the transformation and upgrading of enterprises, and it is the result of the behavior of the enterprises and market competition. The quality of economic development is attributive to many complicated factors. Environmental regulation, as an important means to control pollution by the government, stimulates the upgrading of industrial structure and affect the quality of economic development. How this can be achieved? Is there a benign interaction and transmission mechanism among environmental regulation, transformation and the upgrading of industrial structure and high-quality economic development? If so, what is its specific mechanism? In the context of China's high-quality economic development, this paper explores the interaction between environmental regulation, industrial structure and economic development, which may have a guiding significance for the government to formulate environmental regulation measures in a scientific way, upgrade industrial structure in an effective way and achieve high-quality economic development in an unprecedented way. The main contributions of this paper are to build a comprehensive index for economic development, clarify the relationship among environmental regulation, industrial structure and economic development, proposes that environmental regulation is an influence mechanism on economic development through industrial structure, and contributes humbly to the existing researches in this particular field.

2 Theoretical Analysis

2.1 The effect of environmental regulation on industrial structure

Environmental regulation is a great influencer on the upgrading of industrial structure. Its symbolic view is the "pollution shelter hypothesis" [1] initiated by Copeland and Taylor (1994). The government has formulated more and more strict environmental regulation policies to "drive" the big enterprises in densely-populated areas with more pollutant emissions and energy consumption to the sparsely-populated areas with no or not-so-strict environmental regulations; as a result, these areas not only became their "new home", but also a shelter where pollution makers can escape punishment for the government or environmental enforcement. This movement leads to the transfer of industry space and the formation of industrial space agglomeration phenomenon, thus affecting the upgrading and transformation of industrial structure. In their empirical research on the trade and exports of ecological efficiency in both developed countries and developing countries, Michida and Nishikimi (2007) have discovered that the output in the developed countries and regions mainly include high efficiency clean products, but in developing countries and regions the output is usually made up of low ecologically efficient polluting products, as a result developing countries and regions have been forced to become the shelters for the pollution industry of the developed countries and regions [2]. So far, by using the hypothesis of

pollution shelter, the Chinese scholars have spared no effort to undertaken numerous empirical researches on industrial structure. Yang Haisheng et al. (2005) found that environmental regulation will transfer enterprises with serious environmental pollution to areas with low ecological regulation, and their conclusions have given support to the hypothesis of pollution shelter [3]. Li Chunmi (2010) held that environmental regulation boasts various effects on the structural changes of different industries, while environmental regulation has oblivious effect on the structural changes of the primary industry, but claims to have a notable effect on the structural changes of the secondary and tertiary industries [4]. Wang Xun (2011) makes an empirical examination of the regional differences of industrial and structural changes from the aspect of the environmental regulation in order to show that the eastern region embraces greater structural changes than the central region and the central region embraces greater structural changes than the western region[5]。

2.2 The impact of environmental regulation on economic development

The symbolic views of the influence mechanism of environmental regulation on economic development include following the cost hypothesis and the technological innovation hypothesis. The cost hypothesis means that environmental regulations will increase production costs against economic growth (Jorgenson and Wilcoxen (1990); Walley and Whitehead (1996); Chintrakarn (2008)) [6-8]. The technological innovation hypothesis means that environmental regulation will force enterprises to carry out technological innovation, take the first-mover advantage in the market, enhance the competitiveness of enterprises, and maintain conducive to economic growth (Porter (1991); Xepadeas and De.Zeeuw(1999); Brunnermer and Cohen(2003))[9-11]. The actual situation of the impact of the environmental regulation of the Chinese government on economic growth has attracted a large number of scholars. The research conclusions of Wu Mingqin et al. (2016) support the innovation compensation hypothesis that long-term and stable environmental regulation measures have a positive effect on promoting economic growth[12]. However, the empirical research conclusions of Zhao Xiaowei (2014) support the cost hypothesis, where China's environmental regulation policies have pushed up the operating costs of enterprises and played a negative effect on the economic growth rate [13]. Some scholars have found that environmental regulation and economic growth does not simply possess positive or negative relationships, but a U-or N-shaped relationship (Xiong Yan (2011); Wang Hongqing (2016)) [14,15]. Different scholars have different conclusions on China's relationship between environmental regulation and economic growth, which is attributable to their data time node, estimation model and the selection of measurement index difference, but most of them are mainly concerned with quantitative economic growth, while qualitative research is usually ignored.

2.3Impact of environmental regulation on industrial structure and economic development

Environmental regulation promotes the upgrading of industrial structure, which will lead to a faster economic development. Theoretical mechanism of environmental regulation has a great effect on the upgrading of the industrial structure: Based on the coBob Douglas production function, the environmental factors are introduced as the endogenous variables of the model to construct the relationship among environmental regulation, industrial structure and economic growth. Domestic scholars aim to take different industries of environmental pollutant

emissions and governance as alternative factors of production into cob Douglas production function and conduct a both intensive and extensive study of China's environmental regulation, industrial structure and economic growth. Through their unremitting effort in unending researches, they have concluded that effective environmental regulation measures can give motivations to the enterprises for an increased technological innovation, clean industrial structure transformation and faster sustainable economic growth.

Existing researches show that environmental regulation can also influence economic growth through a variety of conduction paths. By taking the transformation and upgrading of industrial structure as the intermediary transmission mechanism, the author of this paper aims to study how environmental regulation affect the quality of economic development through influencing the changes of industrial structure. Environmental regulation on the influence of industrial structure mainly consists of two paths: The first one is "pollution shelter" hypothesis, which means to realize the industrial space agglomeration through the migration of polluting industries. The migration of polluting industries brings the scale effect and space spillover effect of environmental pollution control cost, which will save the cost of the government and thus play a positive role in promoting the quantity and quality of economic growth. The second path is the assumption of “technological innovation”. Through technological innovation, polluting industries can be updated and replaced with clean industries. The emergence of new clean industries will surely pose a positive effect on promoting the quantity and quality of economic growth.

Thus, the following research hypotheses are proposed:

Hypothesis 1: Environmental regulation affects the high-quality economic development through the industrial structure as a transmission mechanism.

Hypothesis 2: Environmental regulation causes the migration of polluting industries. The scale effect and space spillover effect reduce the cost of environmental pollution control and thus promote high-quality economic development.

Hypothesis 3: Environmental regulation encourages enterprises to make technological innovation, produce new clean industries, reduce the emission of environmental pollutants, and promote high-quality economic development.

3 Model Setting, Variable Selection and Data Source

3.1 Model Setting

Firstly, the square item of environmental regulation is introduced to capture the nonlinear trend between environmental regulation and economic development. Secondly, environmental regulation and industrial transfer, environmental regulation and industrial transformation are introduced to test how environmental regulation affects economic development through industrial transfer and industrial transformation.

3.2 Variable Selection

1. Interpreted Variables

Economic development EN: Economic quantity index is measured by per capita GDP. Energy consumption per unit GDP, wastewater discharge per unit GDP, exhaust discharge per unit GDP, solid waste discharge per unit GDP; Gini coefficient, rural ini coefficient, economic growth volatility and urban registered unemployment rate are to construct comprehensive indicators of economic development by using the principal component analysis method.

2. Core Explanatory Variables

Environmental regulation index ER: The proportion of local investment invested in environmental governance in GDP is important. The greater the proportion of investment invested by local governments in environmental governance in GDP, the greater the intensity of environmental regulation will become.

3.Intermediary Variables

TRAN: The proportion of fixed asset investment in polluting industries in a province (municipalities or autonomous region) is compared with the proportion of fixed asset investment in national polluting industries in national fixed asset investment.①

New industrial development index INNO: The proportion of local fixed asset investment in new industries in a province (municipality or autonomous region) is compared with the proportion of national fixed asset investment in new industries in national fixed asset investment.②

4. Controlling Variables

Urbanization rate URB: The economic development speed of the Chinese cities and towns is obviously faster than that of the rural areas. Urbanization is an important factor affecting economic development. This paper measures the urbanization rate by using the proportion of the permanent urban population to the total population.

EDU per capita year of education: The empirical research shows that human capital is an important factor affecting economic growth. This paper uses the average year of education as a proxy variable of human capital.

Social dependency ratio DR: The empirical research shows that demographic structure is an important factor affecting economic development. The main reason for China's rapid economic growth rate at the end of the 20th century is the demographic dividend. This paper measures the impact of population structure on economic development by dividing the sum of

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①New industries are in accordance with the provisions of polluting industries in *Industrial Classification for National Economic Activitie*s (G B / T 4574-2017) (Fourth Edition) revised by the State Standardization Commission in 2017, including mining industry, textile industry, paper industry, petroleum processing industry, etc.

②New industries are in accordance with the provisions of new industries in Industrial Classification for National Economic Activities (G B / T 4574-2017) (Forth Edition) revised by the State Standardization Commission in 2017, including computer, communication and other electronic equipment manufacturing, comprehensive utilization of waste gas resources and other clean industries.

the population aged 0-14 years and those over 65 years by the population aged 15-64 years as the social dependency ratio.

Foreign direct investment FDI: The rapid development of China's economy is inseparable from foreign direct investment. This paper uses foreign direct investment (FDI) to measure the impact of foreign investment on economic development.

3.3Data Source

The Environmental Protection Committee of the National People's Congress was established in China in March 1993, and it is the highest authority of environmental regulation, marking the initial formation of the environmental regulation pattern. Considering the policy lag, this paper selects China 2000-2018 Provincial Panel Data for study samples. Because of the incomplete data collection, Tibet, Hong Kong, Macao, and Chinese Taiwan are not included in the empirical analysis. Altogether we have collected 540 observations form 30 provinces (municipalities or autonomous regions) spanning 18 years. The data of economic development level, environmental regulation industrial structure and other controlling variables are selected from China Statistical Yearbook, China Environmental Statistical Yearbook and China Industrial Economic Statistical Yearbook. Following is the variables selected from the yearbooks, as is shown in Table 1.

Table 1. Descriptive Statistics of the Variables

Variable Name	Observed Number	Mean	Standard Error	Least Value	Crest Value
EN	540	0.4865	0.1638	0.1078	0.8863
ER	540	5.6352	3.8126	0.1693	32.5386
TRAN	540	0.8623	0.0536	0.0207	3.2481
INNO	540	0.9134	0.1365	0.2587	4.0526
URB	540	0.4876	0.1532	0.2335	0.8981
EDU	540	7.6452	0.3982	3.7321	15.2394
DR	540	0.3488	0.0741	0.1932	0.5762
FDI	540	0.2982	0.1932	0.1035	1.1263

4 Empirical Analysis

4.1 Model Selection

According to the general steps of the panel model setting, it is necessary to examine whether there are individual effects and panel trend. It is significant to use F test to compare whether the difference between the mixed O LS regression and fixed effect model. With x2=51.3326 in F statistics, the accompanying probability is P =0.0019, which implies that the individual

effect of the significance of the model and the necessity of the panel model setting. Next, the Hausman test is employed to determine the fixed effect and random effect models of the panel. With x2=29,2531 in Hausman test, the accompanying probability is P =0.0003, and the null hypothesis is rejected (individual effects are not related to the explanatory variables), which indicates that the fixed effect should be selected to make estimations (see Table 2).

Table 2. Panel Model Selection for the Impact of Environmental Regulation on Economic Development

Variable	Mixing OLS	Stochastic Effect	Fixed Effect
ER	-0.1041** (-1.9341)	-0.1239** (-2.3681)	-0.1161** (-2.2368)
ER2	0.0045* (1.9365)	0.0056** (1.9839)	0.0062** (2.1638)
TRAN	0.3257*** (3.1235)	0.3052*** (3.2136)	0.3126*** (3.0275)
INNO	0.0358*** (13.2157)	0.0403*** (12.9041)	0.0392*** (13.8865)
ER*TRAN	0.3586** (2.3685)	0.4732** (2.0631)	0.3592** (2.0631)
ER*INNO	0.0618*** (7.1325)	0.0468*** (6.9325)	0.0537*** (7.3214)
URB	0.0614* (1.9103)	0.0631** (2.0056)	0.0582** (2.2105)
EDU	0.1312** (2.0816)	0.1627** (1.9869)	0.1432** (2.1324)
DR	-0.0961** (2.5831)	-0.0912** (1.9943)	-0.0887** (1.9725)
FDI	0.2132** (2.2356)	0.2631** (2.1506)	0.2365** (2.0606)
Sample Capacity	540	540	540
F-test	x2=51.3326	p=0.0019	
Hausman Test		x2=29.2531	p=0.0003

Note: *, * * and * * * indicate that the estimated coefficients are significant at 10%, 5% and 1%, respectively, and the value of square brackets under the coefficient is the t-statistics.

4.2 Empirical Results

Aiming at the examination of the direct impact of environmental regulation on economic development and the indirect impact through industrial transfer and new industrial

development, the author, in this paper, has constructed a gradual regression estimation method for comparison (see Table 3). Model 1 represents the sole impact of environmental regulation on economic development. The estimation shows that strict environmental regulation significantly inhibit economic development, but the quadratic estimation coefficient of environmental regulation is insignificant. Model 2 shows that with the introduction of industrial structure variables, the influence of environmental regulation on economic development changes from positive linear trend to U-shaped curve. In the early stage of policy instability, frequent changes in policies are not conducive to economic development, and in the later stage, the environmental regulation has yielded policy dividend, which have greatly improved economic development. The transfer of pollution industry has achieved an obvious positive impact on economic development. The emergence of new industries poses an obvious effect on a faster economic development. Compared with Model 2, Model 3 increases the terms of environmental regulation and industrial transfer, and the size and significance of the estimated coefficient are further improved, which indicates that under the influence of environmental regulation policies, pollution industry transfer brings scale effect and space spillover effect of pollution control. Compared with Model 2, Model 4 adds the intersection of environmental regulation and new industries, and the estimated coefficient is positive, and passes the significance level of 1%, which indicates that under the influence of environmental regulation policies, enterprises' industrial transformation innovation has obviously promoted economic development through technological innovations. Model 5, compared with Model 2, will join the environmental regulation and industrial transfer, environmental regulation and new industry. Compared with Model 3 and Model 4, Model 5 has an estimated slightly reduced coefficient and few significant changes, which simply means that considering the influence of the new industry development, it may be overestimated in its function and effect. There may be some checks and balances between them, because there exist certain alternative relationship between the professional transfer and new industry development themselves. The above estimates show that China's environmental regulation measures have achieved initial results, which is of great value in an effort to direct the economic development onto the high-quality track through the two transmission mechanisms of industrial transfer and industrial transformation.

The estimation results of other control variables reveal that the higher the proportion of urbanization, the higher the concentration degree of industry and services, which will promote the economic development. The higher the proportion of the population with higher education, the higher value the human capital will obtain, and more conducive it will become to economic development. The higher the social dependency ratio, the greater burden the social dependency will have to shoulder, and it has a negative inhibitory effect on economic development. The higher the proportion of foreign direct investment in financial support for regional development, the higher quality the economic development will achieve.

Table 3. Environmental Regulation Panel Model Evaluation for Economic Development

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
ER	-0.1236***	-0.1038*	-0.1052*	-0.1096**	-0.1161**
	(3.2136)	(-1.8613)	(-1.9325)	(-2.0738)	(2.2368)

ER2	0.0068 (1.7365)	0.0043** (2.0928)	0.0045** (2.2863)	0.0051** (2.6831)	0.0062** (2.1638)
TRAN		0.3257*** (3.1424)	0.3304*** (3.2365)	0.3057** (2.2586)	0.3126*** (3.0275)
INNO		0.0423*** (15.3084)	0.0403*** (14.6721)	0.0417*** (14.4282)	0.0392*** (13.8865)
ER*TRAN			0.4731** (2.1356)		0.3592** (2.0631)
ER*INNO				0.0712*** (7.6314)	0.0537*** (7.3214)
URB	0.2317** (2.0931)	0.0623* (1.9326)	0.0631** (2.0056)	0.0568** (1.9876)	0.0582** (2.2105)
EDU	0.2315** (2.2876)	0.1526** (2.0315)	0.1627** (1.9869)	0.1513** (2.0125)	0.1432** (2.1324)
DR	-0.0961** (2.5831)	-0.0869** (1.9863)	-0.0912** (1.9943)	-0.0904** (2.0341)	-0.0887** (1.9725)
FDI	0.1359** (2.1864)	0.2418** (2.1187)	0.2631** (2.1506)	0.2104** (1.9846)	0.2365** (2.0606)
Sample Capacity	540	540	540	540	540

Note: *, * * and * * * show that the estimated coefficients are prominent at 10%, 5% and 1% respectively, and the value of square brackets under the coefficient is the t-statistics

5 Conclusion

Using the interprovincial panel data from 2000 to 2018 , this paper has examined the effect of environmental regulations on the quality of economic development from the transmission mechanism of industrial structure optimization. From this present research, the author of this paper has drawn the following conclusions: (1) Environmental regulation has a direct negative effect on the quality level of the economic development, which can help to explain the check and balance between economic development and environmental regulation policies in many regions. (2) The scale effect and space spillover effect of pollution control brought by environmental regulation through transferring polluting industries to centralized industrial parks will undoubtedly provide an impetus to a faster economic development.(3) After the implementation of environmental regulation policies, enterprises, especially those of medium-and-large sizes, are encouraged to make scientific and technological innovations, eliminate backward and undesirable industries, develop new environmental protection industries, and effectively promote high-quality economic development.

In accordance with the conclusions of this research, environmental regulation poses a direct and negative effect on the quality of economic development, which shows that environmental

protection policies are playing a primary and positive role in the process of promoting supply-side reform. The short-term slowdown of economic development is based on environmental benefits as the constraint condition. Therefore, local governments are in the position to change the development concept of “GDP only” as quickly as possible in order to re-establish the new concept of high-quality economic development with ecological environment protection as the constraint condition. The direct result of environmental regulation is the production behavior of different enterprises. Under the high-intensity environmental regulatory policy, most of the enterprises face two alternatives. The first alternative aims to move industries to areas with relatively low regulatory measures for centralized pollution control so as to realize the scale effect and space spillover effect of pollution control. The second alternative attempts to upgrade the industry, replace traditional industries with new ones with low energy consumption and low emissions, and drive industrial structure upgrading by innovation, thus promoting high-quality economic development. Empirical researches have found that both industrial transfer and industrial substitution boast an obvious positive effect on economic development. It shows that the upgrading of industrial structure is performing positively between environmental regulation and high-quality economic development. Therefore, local governments should establish a mechanism to undertake industrial transfer projects in order to promote the reasonable and effective transfer of polluting industries, strengthen regional interaction, cooperation and exchanges, give guidance to polluting industries in their effort to gather in the same area, and realize the scale effect of pollution control. On the one hand, it is important to give guidance; on the other hand, it is necessary to carry out scientific and technological innovation to realize the upgrading of traditional industries, promote the development of new environmental protection industries, give support to new environmental protection industries in subsidies and innovation, and compensate and encourage the R & D costs of enterprises for active innovation. By focusing on building high-tech environmental protection industrial clusters with low energy consumption in construction, high industrial chain correlation, and a good model for the upstream and downstream industries, we will surely increase investment in a cleaner production transformation,

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