The Influence of Environmental Regulation Tools on Industrial Structure

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Keywords: Environmental Regulation Tools; Industrial Structure; Spatial Heterogeneity

Abstract: When the sustainable development of economy is faced with tightening environmental constraints and transformation pressure, industrial structure adjustment has become the key path to solve the "dilemma" pattern of promoting growth and reducing emission reduction. This paper selects the provincial panel data of 29 provinces in 2005-2015 years, divides the environmental regulation into the command-type environmental regulation, the market incentive environmental regulation and the Public Participation environment regulation, and probes into the influence of different environmental regulation tools on the industrial structure. At the same time, the spatial heterogeneity of environmental regulation in the eastern and central regions is further studied. The results show that adopting an environmental regulation tool alone, such as a command-type environmental regulation tool, may have a negative impact on the industrial structure, but the results are not significant, the incentive environmental regulation is a significant positive action for industrial structure upgrading, and the comprehensive use of various environmental regulations significantly improves the positive impact of environmental regulation. And the results show that there is a real spatial heterogeneity, and the policy effect in the Middle East is more obvious.

1. Issue raised

In recent years, China's economic construction has gradually entered a stage of high quality development, and people's life has entered a new era. With the continuous development of economy and the basic realization of a well-off society in an all-round way, people's demand for quality of life is higher and higher, and the demand for living environment is higher and higher. The CPC Central Committee and the State Council attach great importance to the protection of the ecological environment. Since the 12th Five-Year Plan, they have resolutely declared war on pollution and continuously increased the protection of the ecological environment. Industrial structure adjustment is the key path to coordinate economic sustainable development and environmental protection. Environmental regulation is an important way of environmental protection, by changing the cost of enterprises, thus affecting the profits of enterprises, The product structure, technical level and management mode are close and affect the business decision. There are different classification of environmental regulation tools. So the impact of different environmental regulation tools on industrial structure is the same? is it promotion or hindrance? Are the effects similar for different regions? This paper makes an empirical analysis of provincial panel data in 30 provinces from 2005 to 2015. Hope to provide some reference suggestions for the formulation of environmental regulation policy.

2. Theoretical Analysis and Research Hypothesis

The methods of measuring environmental regulation are diversified and constantly enriched. Starting from the initial definition of environmental regulation, environmental regulation is summed up as economic means only, so it puts forward "formal environmental regulation" to expand and enrich continuously later, and thinks that environmental regulation is not only economic means or social means (Zhao Yumin ,2009), thus puts forward the corresponding "informal environmental

regulation ". "Formal environmental regulation" can be subdivided into command-controlled environmental regulation, market-based incentive environmental regulation; informal environmental regulation (former Yijun, Xie Rong ,2014) angle is also Zhao Yumin (2009) recessive environmental regulation theory, Peng Xing (2016) self-conscious environmental theory and Yu Xiao (2017)'s exogenous environmental regulation policy. Therefore, the selection of environmental regulation tools and index measurement is an important factor affecting the analysis results.

Explore the impact of environmental regulation on industrial structure adjustment representative theory there are three main: first," follow the cost theory ", strict environmental regulation will internalize the negative externalities of pollution into production costs (Millimetetal, 2009). Second is the "pollution shelter hypothesis ", which holds that in the open economy, in order to avoid regulation or reduce the cost of compliance, the pollution industry is transferred across regions, which leads to the adjustment and change of industrial structure (Solarinetal,2017). The third is "Porter hypothesis ", that is, appropriate environmental regulation will stimulate enterprises to carry out technological innovation, slow down or offset the environmental costs of enterprises, generate innovation compensation effect and then achieve Pareto improvement (Porteretal., 1995; Zhang Cheng et al .,2011). Former Yijun put forward that environmental regulation has a forced effect on industrial structure adjustment and upgrading, and thought that environmental regulation and industrial structure upgrading show a U relationship; Shi Fengguang (2017) found that environmental regulation has little impact on economic growth, but increasing the intensity of pollution control is helpful to the optimization of industrial environmental structure.

The conclusion of spatial heterogeneity is not consistent. For example, some studies have found that environmental regulation mainly promotes industrial structure adjustment in the eastern region and has little or no significant impact on the central and western regions (Li Qiang ,2013; Xiao Xingzhi et al .,2013; Han Jing et al .,2014), but some studies have found that environmental regulation has a greater effect on industrial structure adjustment in the central and western regions (Li Jian ,2013; Zheng Jinling ,2016).

By reading the classification criteria of environmental regulation tools in previous literature, this paper selects command-controlled environmental regulation, market-based incentive environmental regulation and public participation environmental regulation as classification criteria, selects relevant metrics to study the impact of different environmental regulation tools on industrial structure, and gives its own conclusions for spatial regional heterogeneity.

Data and research design

2.1. Samples and Data

This paper selects panel data from 29 provinces in 2005-2015(data availability and completeness based excluding tibet, xinjiang, hong kong, macao special administrative region and taiwan, china). From the previous years, the original data came from the China Statistical Yearbook, the China Environmental Yearbook, the China Industrial Statistics Yearbook, the National Intellectual Property Annual Report, the provincial annual database and the EPS database on the website of the National Bureau of Statistics.

2.2. Research Design

In order to accurately assess and identify the impact of environmental regulation on industrial structure adjustment and its action mechanism, this paper constructs a related measurement model. The details are as follows:

$$\mathrm{ISD}_{i,t} = \beta_0 + \beta_1 \mathrm{ERKZ}_{i,t} + \beta_2 ERJL_{i,t} + \beta_3 ERCY_{wage,i} + \beta_4 ERCY_{age,i} + \beta_5 lncon + \beta_6 lvr\&d + \gamma X + \varepsilon_{i,t}$$

Among : i Province(i = 1 ， 2， …， 29) ， t time

Explained variable: industrial structure (ISD). The industrial structure adjustment includes the

structural change within the three industries and the structural change between the three industries, which is consistent with the practice of Yuan Yijun et al .(2014) and Li Qiang (2013). This paper defines the industrial structure adjustment as the structural change between the three industries. It is measured by the proportion of the added value of the tertiary industry and the added value of the secondary industry in each province.

The core explanatory variables: environmental regulation (ER), using you Daming (2018) to divide environmental regulation into command-controlled environmental regulation tools (ERKZ), market-motivated environmental regulation tools (ERJL) and public participation environmental regulation tools (ERCY). In this paper, the ratio of industrial wastewater discharge in each region to product sales above the scale of each region is selected to represent the command-controlled environmental regulation tool. The smaller the amount of pollution per unit of sales, the stronger the government's environmental regulation in the region. Choose the proportion of environmental pollution control investment in regional GDP (GDP) to measure the market incentive environmental regulation tools.

Drawing on (Yuan Yijun, 2014) and considering the availability of data to select variable income level ($ERCY_{wage,i}$), this paper uses the average wage of urban employed workers to measure the income level of each province. Age structure ($ERCY_{age,i}$), provinces with a high proportion of young people will be more concerned about pollution and more involved with environmental NGOs. This paper selects the proportion of the population aged 15-64 in the total population of each province.

Other explanatory variables: with reference to available literature and data possibilities, we choose: Technological innovation (lnr&d), using the logarithm of patent authorizations per region as a measure. Consumption demand (lncon), taking the logarithm of the consumption level of the residents in each region as a measure.

Table 1. Descriptive statistical analysis of variables

Variable	Den,	Obs	Mean	Std.Dev	Min	Max
ISD	Ratio of the added value of the tertiary industry to the added value of the secondary industry in each province	319	0.951628	0.511348	0.497053	4.035482
ERKZ	Emissions of industrial wastewater from provinces and sales of products above regional scale	319	5.145892	5.860272	0.339995	46.45171
ERJL	Investment in environmental pollution control in provinces as a proportion of regional GDP (GDP)	319	1.323856	0.59542	0.4	3.76
$ERCY_{wage,i}$	Average wages of employed workers in cities and towns	319	38104.91	17518.38	13688	113073

$ERCY_{agei}$	Proportion of population aged 15-64 in provinces	290	0.7364046	0.0376264	0.6346009	0.8384523
LNCON	Logarithmic levels of consumption by province	319	12050.15	7455.023	3256	45816
LNRD	Logarithmic number of patent authorizations per province	319	8.985861	1.627114	3.78419	12.50597
URB	Ratio of urban population to resident population at the end of each province	319	9.234694	0.5625004	8.088255	10.73239
SCAL	Total fixed assets investment in provinces	319	9743.775	8570.89	329.81	48312.44

3. Mpirical test

Table 2. Regression Results

VARIABLES	(1) ISD	(2) ISD	(3) ISD	(4) ISD
ERKZ	-0.000669			0.00409*
	(0.00487)			(0.00440)
ERJL		0.0394*		0.0399*
		(0.0414)		(0.0381)
ERCYwagei			3.46e-05***	3.49e-05***
			(3.59e-06)	(3.60e-06)
ERCYagei			-1.163	-1.163
			(0.903)	(0.932)
lncon	0.399***	0.407***	-0.913***	-0.939***
	(0.116)	(0.114)	(0.169)	(0.170)
lnrd	0.00530	0.000673*	0.0641***	0.0636***
	(0.0173)	(0.0173)	(0.0163)	(0.0172)
URB	0.760*	0.773*	2.119***	2.134***
	(0.402)	(0.401)	(0.413)	(0.414)
SCAL	-2.51e-05***	-2.53e-05***	-1.21e-05***	-1.26e-05***
	(4.06e-06)	(4.04e-06)	(3.81e-06)	(3.83e-06)
Constant	-2.932***	-2.921***	7.332***	7.665***
	(0.938)	(0.919)	(1.321)	(1.360)
Observations	319	319	290	290
R-squared	0.346	0.348	0.522	0.526

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

we regress the industrial structure of the explained variable by three environmental regulation tools respectively. from the regression results in table 2, we can see that the individual

command-line environmental regulation tools have a negative impact on the industrial structure, but have not passed the significance test. This may be because a separate mandatory environmental regulation policy may result in a large increase in the cost of enterprises, followed by the diversity of national policies and difficult to measure the characteristics of variable selection may not be reasonable, resulting in different regression results. Individual market-driven environmental regulation policies have a significant positive impact on the industrial structure, probably because they are softer, To the enterprise has certain buffer space, the enterprise based on the long-term consideration, will carry on the necessary green innovation, thus promotes the industrial structure optimization. The state will also give certain subsidies to enterprises to some extent offset the costs of enterprises because of the governance environment. The regression results of public participation environmental regulation show that the higher the income level of a place, the stronger the awareness of citizens' participation in environmental protection, which is more conducive to the optimization of industrial structure. The age structure does not pass the significance test and is negative, which may be because the proportion of middle-aged population is relatively large in the population aged 15-64, and because the environmental regulation of our country is still in the exploratory stage, Environmental publicity and popularization is not enough, but for middle-aged people, environmental awareness is relatively weak, environmental participation is not high.

The overall regression results show that the comprehensive environmental regulation tools have a significant positive impact on the industrial structure, which indicates that the government should make comprehensive use of various types of environmental regulation tools to produce a favorable positive impetus to the industrial structure.

Among other explanatory variables, the consumption level of residents significantly positively affected the industrial structure, reaching 95%. It shows that environmental regulation tools can influence the industrial structure by indirectly influencing the consumption level of citizens. On the whole, the technical level has a significant positive impact on the industrial structure, which can prove the validity of Porter's theory to some extent. Among the control variables, urbanization level and industrial scale have a significant positive impact on the industrial structure, indicating that the selection of control variables in this paper is reasonable.

4. Further inspection

In view of whether there is spatial heterogeneity in environmental regulation, we divide the provinces into east, middle and west to carry out regression test respectively.

Table 3. Partition regression junction

VARIABLES	(West) ISD	(Central) ISD	(East) ISD
ERKZ	0.00491	0.0373***	0.0117***
	(0.00434)	(0.0113)	(0.00459)
ERJL	0.102**	0.111**	0.120**
	(0.0327)	(0.0432)	(0.0513)
ERCYwagei	2.05e-05**	2.08e-05**	3.85e-05***
	(2.71e-06)	(8.79e-06)	(3.89e-06)
ERCYagei	-1.067	-4.728***	-2.620*
	(0.851)	(0.975)	(1.328)
lncon	-0.345**	-0.255*	-1.104***
	(0.136)	(0.354)	(0.203)
lnrd	0.0565*	0.0493*	0.0760***
	(0.0120)	(0.0430)	(0.0267)
URB	0.421	2.847***	5.332***
	(0.270)	(0.706)	(0.650)
SCAL	-1.88e-06	-5.36e-05***	-1.31e-05***

	(3.90e-06)	(7.63e-06)	(3.92e-06)
Constant	3.430***	4.978**	8.456***
	(1.114)	(2.387)	(2.023)
Observations	100	80	110
R-squared	0.732	0.715	0.888

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

It is found that the response of industrial structure adjustment to environmental regulation is heterogeneous. Command-based environmental regulation forces industrial structure upgrading in the central and eastern, market-motivated environmental regulation and public participation environmental regulation are mainly in the eastern. It shows that the eastern region has the power to improve the intensity of environmental regulation at present, and the environmental regulation policy has played an obvious role in promoting the adjustment of industrial structure, while the ordered environmental regulation has a great influence on the central part, mainly the pollution enterprises in the central part, and the development of service industry is seriously lagging behind, which has a great room for upgrading. Due to economic backwardness in the west It makes the western region's desire to catch up with the economy more intense, so the significance and coefficient of environmental regulation to the western region is not as obvious as the central and eastern regions.

Technological innovation can promote industrial structure adjustment, but there are regional differences. The eastern effect is significant and the central and western regions are not significant, the reason may be that the level of technological innovation in the central and western regions is low and cannot promote the adjustment of industrial structure. Foreign trade has significantly suppressed the effect of industrial structure adjustment. The test results of the samples in the Middle East show that the effect of economic scale on industrial structure adjustment is significantly negative, but the effect on industrial structure adjustment in the east is relatively small. This means that the expansion of economic scale in the central and western regions cannot guarantee the smooth progress of industrial structure adjustment.

5. Robustness Test

With reference to previous literature, indicators of explanatory variables can be replaced for robustness tests. In view of the market incentive environmental regulation, the total amount of investment in environmental control is replaced by the completed amount of industrial pollution control. Since China's industrial pollution is an important source of pollution, it is reasonable to replace the total amount of environmental investment with the amount of industrial pollution investment completed：

Table 4. Regression results

VARIABLES	(1) ISD	(2) ISD	(3) ISD	(4) ISD
ERKZ	-0.00232*			0.00399*
	(0.00432)			(0.00432)
ERJL		0.00504***		0.00480***
		(0.00181)		(0.00161)
ERCYwagei			3.46e-05***	3.48e-05***
			(3.59e-06)	(3.54e-06)
ERCYagei			-1.116	-1.031
			(0.903)	(0.914)
CON	4.49e-05***	0.369***	-0.913***	-0.970***

	(6.42e-06)	(0.113)	(0.169)	(0.168)
RD	-2.90e-07*	0.000306	0.0641***	0.0634***
	(5.21e-07)	(0.0167)	(0.0163)	(0.0166)
URB	0.115	0.758*	2.119***	2.086***
	(0.318)	(0.397)	(0.413)	(0.409)
SCAL	-2.61e-05***	-2.62e-05***	-1.21e-05***	-1.34e-05***
	(3.13e-06)	(4.01e-06)	(3.81e-06)	(3.79e-06)
Constant	0.624***	-2.518***	7.332***	7.926***
	(0.127)	(0.922)	(1.321)	(1.344)
Observations	319	319	290	290
R-squared	0.420	0.362	0.522	0.538

As a result, the regression results are still significant, and environmental regulation can indeed push the industrial structure to upgrade.

Conclusion

The continuous exploration of regulation tools is the requirement of national development. Reasonable and effective environmental regulation tools not only have direct effect on environmental governance, but also have obvious positive effect on industrial structure upgrading. It is found that the implementation of environmental regulation policy has significantly promoted the adjustment of industrial structure in China and produced a positive effect of structural adjustment, but there are differences in the response of industrial structure adjustment to environmental regulation in the east, middle and west regions. Compared with the western region, the environmental regulation policy has significantly promoted the industrial structure adjustment in the eastern and central regions. The regional heterogeneity of market-ordered regulatory tools is particularly obvious. And the level of consumption and technological innovation the degree of significant impact on the upgrading of industrial structure is an important factor that cannot be ignored.

It can be seen that the formulation of environmental regulation policy in China should not only consider the tools of regulation, but also consider regional differences and the intensity and mode of regulation in different regions should be distinguished, which reflects the characteristics of differentiation. Considering the positive influence of consumption level and technology level on industrial structure, the state should strengthen the propaganda of green environmental protection, guide the public to set up the view of green consumption, and promote the upgrading of industrial structure through consumption upgrading. It is also necessary to improve the innovation system and mechanism, encourage innovation and increase the strength of talent training, and promote the upgrading of industrial structure through innovation.

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