

Multiple Regression Analysis of the Impact of Command Environmental Regulation on Mining Industry Structure Based on Stata Software

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Abstract: In this paper, the inter-provincial panel data of 30 provinces (excluding Xizang) from 2006 to 2017 are selected, the adjustment of the mining industry structure is taken as the explained variable, and the command type environmental regulation, technological innovation, foreign direct investment, enterprise access, mineral resource endowment and market demand are taken as explanatory variables to build a multiple regression analysis model. And stata15.0 software is used to analyze the influence of the command environmental regulation on the adjustment of the mining industry structure, and then put forward the relevant suggestions to optimize the command environmental regulation.

1 Introduction

Environmental regulation has become a global issue. Most countries have adopted mandatory policy measures to regulate the environment^[1]. Our government also comprehensively uses various environmental regulation measures of command type to control pollution and protect environment^[2]. Mining industry occupies the position of basic industry in the development of national economy, but it will also have a serious negative impact on the ecological environment. Therefore, it is of great theoretical and practical significance to carry out in-depth research on the adjustment of the mining industry structure under the background of command-type environmental regulation to promote the development of mining industry and the protection of ecological environment.

2 Variable selection

2.1 Explained variables

Restructuring of mining industry (RMI). The objective of upgrading the industrial structure of mining industry is to obtain new growth points and develop sustainably, which means increasing profits and enhancing product competitiveness. Therefore, this paper uses the ratio of the net profit of main business of mining industry from 2006 to 2017, that is, the total profit and main business income, to measure the level of structural adjustment of mining industry. The larger the ratio of the two, the higher the level of industrial structure adjustment of mining industry.

2.2 Explanatory Variables

Command-controlled environmental regulatory intensity (CER). Command-and-control environmental regulation refers to the laws, regulations and policies on environmental protection formulated by the government that enterprises must abide by^[3]. Mining permits represent the implementation of regulatory measures, and the number of mining permits directly reflects the intensity of command-controlled environmental regulations. Therefore, this paper measures the intensity of command-controlled environmental regulations by the ratio of the number of valid mining permits issued to the number of new mining permits. The larger the ratio is, the higher the threshold for entering the mining industry and the greater the intensity of command-controlled environmental regulations.

Technological innovation (TI) is measured by the intensity of research and experimental development expenditure^[4]. Foreign direct investment (FDI) is expressed as foreign direct investment in mining industry. Enterprise access (EA) is expressed as the number of units of mining enterprises above designated size^[5]. Mineral resource endowment (EMR) is expressed as the proportion of fixed asset investment in mining industry to total fixed asset investment in the whole society. Market demand (MD) is expressed by mineral resource consumption intensity, that is, the input of mineral resource products required per unit of GDP output^[6].

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Table 1 Description of variable indicators			
Type	Name	Symbol	Calculation method
Explained variable	Restructuring of mining industry	RMI	Total profit of mining industry/income from main business of mining industry
	Command-controlled environmental regulation	CER	Number of valid mining permits/number of new mining permits
	Technological innovation in mining industry	TI	Intensity of investment in research and experimental development
	Foreign direct investment in mining industry	FDI	Amount of foreign direct investment in mining industry
	Access to mining enterprises	EA	The number of mining enterprises above designated size
	Endowment of mineral resources	EMR	Fixed asset investment/Total fixed asset investment in mining industry
Explanatory variable	Market demand	MD	Input of mineral resource products required per unit of GDP output

The data for each variable in this paper are derived from China Environmental Yearbook, China Land and Resources Statistical Yearbook, China Science and Technology Statistical Yearbook, China Statistical Yearbook and Local Statistical Yearbook from 2007 to 2018. The variable indicators are described in the following table (Table 1).

3 Model Construction

Regression analysis is a statistical method that studies the relationship between an explained variable and one or more explained variables. In order to empirically analyze how command-type environmental regulations affect the structural adjustment of mining industry, this paper selects data from 2006 to 2017 to establishes the following regression analysis model:

RMI_{it} = \beta_0 + \beta_1 CER_{it} + \beta_2 CER_{it}^2 + \beta_3 TI_{it} + \beta_4 FDI_{it} + \beta_5 EA_{it} + \beta_6 EMR_{it} + \beta_7 MD_{it} + \varepsilon_{it}

In the above model, i is the province, i= 1,2... , 30; t is time, t= 1,2... 12; \beta_0 is a constant term; \beta is the coefficient of each variable; CER is an explanatory variable, indicating command-controlled environmental regulation. TI, FDI, EA, EMR and MD are control variables, respectively representing technological innovation, foreign direct investment, enterprise access, mineral resource endowment and market demand. CER^2 is the second term of command-controlled environmental

regulation, which aims to verify whether the impact of command-controlled environmental regulation on the structural adjustment of mining industry is nonlinear. \varepsilon is a random perturbation term. This paper uses stata15.0 software to conduct regression analysis of provincial panel data from 2006 to 2017 in 30 provinces (autonomous regions) except Xizang.

4 Descriptive analysis of data

Table 2 Descriptive statistics of variables					
Variable name	Sample value	Mean value	Standard deviation	Maximum value	Minimum value
Restructuring of mining industry	360	0.1327	0.0721	0.4934	-0.0921
Command-and-control environmental regulation	360	35.9437	18.7146	117.5	6.1084
Technological innovation in mining industry	360	1.8175	0.2568	2.13	1.42
Foreign direct investment in mining industry	360	5385	3041.23	17103	137
Access to mining enterprises	360	387	300	1930	56
Endowment of mineral resources	360	0.0333	0.0103	0.0446	0.0144
Market demand	360	0.0994	0.0237	0.1294	0.0575

Note: The data in this table are descriptive statistics of original values without logarithmic processing

The descriptive statistical results of the data are shown in the above table (see Table 2) :

From 2006 to 2017, the mean value of the adjustment of the mining industry structure is 0.1327, the maximum value is 0.4934, and the minimum value is -0.0921, indicating that there are great differences in the adjustment level of the mining industry structure in different regions and different years. The mean of the command-controlled environmental regulation is 35.9437, the maximum value is about 19 times of the minimum value, which shows that there are obvious differences in the intensity of environmental regulation in different regions of our country. There is also a certain gap between the maximum and minimum values of enterprise access, mineral resource endowment, market demand, technological innovation and foreign direct investment. This difference guarantees certain variance changes in the study, and provides data support for analyzing the correlation between the command environmental regulation and the mining industry structural adjustment^[7].

5 Correlation analysis

In this paper, stata15.0 software was used for analysis and pearson correlation coefficient was used to analyze the correlation between the two variables. It can be seen from the RMI column: The coefficients of RMI and EA and EMR were -0.293 and -0.524, respectively, and were significant at the significance level of 0.1%, that is, RMI

and EA showed a significant negative correlation. The coefficients of RMI and CER and MD were 0.437 and 0.278, respectively, and were significant at the significance level of 0.1%, that is, RMI showed a significant positive correlation with CER and MD (see Table 3). It shows that there is a correlation between the explanatory variable and the explained variable, and it is necessary to do further regression analysis.

Table 3 Correlation analysis of variables

	RMI	CER	TI	FDI	EA	EMR	MD
RMI	1						
CER	0.437***	1					
TI	-0.119	0.109	1				
FDI	-0.068	-0.091	-0.073	1			
EA	-0.293***	-0.258***	-0.045	0.034	1		
EMR	-0.524***	-0.151*	-0.375***	-0.076	0.081	1	
MD	0.278***	0.111	-0.177*	-0.026	0.375***	0.700***	1

Note: *p<0.05, ** p<0.01, *** p<0.001

6 Regression results and analysis

In this paper, Stata is used to test the balance of 360

provincial sample data. The results show that the number of samples is 30 and the time dimension is 12, which accords with the actual situation. Therefore, the panel data belongs to the balanced panel data.

Table 4 Results of regression analysis

VARIABLES	FE	RE
	RMI	RMI
CER	-0.927*** (3.382)	-0.803*** (3.281)
CER ²	0.877*** (0.457)	0.759*** (0.458)
TI	0.379*** (0.2988)	0.273* (0.1693)
FDI	-1.18e-07 (-1.229)	-5.37e-08 (-0.548)
EA	-3.20e-05 (-0.664)	-4.30e-05 (-1.110)
EMR	-0.831** (2.630)	-0.593** (3.669)
MD	0.589*** (3.911)	0.301** (2.290)
Constant	0.0797 (1.151)	0.0597 (1.025)
Observations	360	360
R-squared	0.449	0.4146
Number of code	30	30
F	14.12	
Wald chi2		69.80
Prob	0.0000	0.0000

t-statistics in parentheses

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

Test: Ho: difference in coefficients not systematic

chi2(2) = (b-B)'[(V_b-V_B)⁻¹](b-B)

15.40

Prob>chi2 = 0.0088

(V_b-V_B is not positive definite

Hausmann test was used to compare the fixed effects model and the random effects model, and the results

showed that the P value was 0.0088, less than the given significance level of 0.05, meeting the conditions of the

fixed effects model. Therefore, the fixed effect model is obviously superior to the random effect model, so the fixed effect model is selected for empirical analysis. FE results of the fixed effect model show that R-squared is 0.449, the goodness of fit of the model is moderate, and the independent variables of the model can explain most of the information of the dependent variables. The F value of the model is 14.12, and the corresponding P value is 0. Therefore, it is considered that the model as a whole is significant, that is, the coefficients of all variables in the model are not all 0.

According to the regression analysis results in Table 4, it can be seen that:

The effect of administrative order environmental regulation on the adjustment of mining industry structure is nonlinear. The command-controlled environmental regulation has a negative effect on the structural adjustment of mining industry in the short term. When the intensity of administrative order environmental regulation increases by 1%, the structural adjustment degree of mining industry decreases by 0.927%. The reason is that the administrative order type environmental regulation measures are mandatory, and mining enterprises must update equipment and technology and increase pollution control facilities in accordance with the requirements. This increases the production cost of enterprises in the short term, occupies the capital space of the industrial structure adjustment of mining enterprises, and then leads to a slower growth rate of output value, hindering the industrial structure adjustment of mining industry^[8].

The coefficient of the secondary term of administrative order type environmental regulation is positive and significant at 1% level, indicating that there is a threshold value between administrative order type environmental regulation and the structural adjustment of the mining industry.

Among the control variables, technological innovation and market demand have significant positive effects on the structural adjustment of mining industry. Mineral resource endowment has a significant negative effect on the structural adjustment of mining industry^[9]. Foreign direct investment in mining industry and access to mining enterprises have no significant impact on the adjustment of mining industry structure.

7 Conclusion

The empirical results show that the impact of administrative order environmental regulation on the structural adjustment of mining industry is a nonlinear relationship. There is a threshold value between the administrative order type environmental regulation and the industrial structure adjustment of mining industry^[10]. The optimization and adjustment degree of the industrial structure of mining industry can be improved only when the intensity of the administrative order type environmental regulation passes a certain inflection point. Our inspiration for environmental regulation is that we should improve the laws and regulations on environmental protection, rationally set the intensity of command-

controlled environmental regulation, and promote the optimization and upgrading of the structure of mining industry.

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