Multiple regression analysis of the impact of market incentive environmental regulation on mining industry structure based on stata software

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Abstract: Based on the provincial panel data of 30 provinces except Xizang from 2006 to 2017, this study constructs a multiple regression analysis model with the optimization of mining industry structure as the explained variable, market incentive environmental regulation as the explanatory variable, and technological innovation, enterprise access, foreign direct investment, market demand for mineral products, and resource endowment of mineral resources as the control variable. In addition, stata15.0 software was used to empirically analyze the influence of market incentive environmental regulation on the adjustment of mining industry structure at the national level, and to compare and analyze the influence of market incentive environmental regulation on the optimization of mining industry structure in the eastern coastal areas and the central and western regions. Finally, according to the results of regression analysis, corresponding suggestions are put forward.

1. Introduction

Market incentive regulation means in the form of environmental tax and emission trading, which can reduce regulation costs and increase regulation flexibility, are playing an increasingly important role[1]. The market-motivated environment regulations in mining field put forward green, environmentally friendly new requirements for our country mining industry economic development, and force the adjustment of the mining industry structure[2]. In this context, it is of great practical significance to clarify the specific impact of market incentive environmental regulation on the optimization of mining industrial structure and its regional differences for optimizing environmental regulation measures and promoting the upgrading of mining industrial structure.

2. Variable selection and model setting

This paper selects the data of 30 provinces in China except Tibet from 2006 to 2017. Some variables are directly derived from the China Environment Yearbook, China Land and Resources Statistics Yearbook, China Science and Technology Statistics Yearbook, China Statistics Yearbook and local statistics yearbook. Some variables are calculated after sorting.

2.1.Variable selection

Explained variable. Mining industry structure optimization (MISO). The optimization of the mining industry structure refers to the optimization of the internal structure of the mining industry and its product structure, asset structure, labor structure and technical structure[3]. One of its important manifestations is that the industry obtains new growth points and sustainable development. Therefore, this paper uses the ratio of total mining profit to main business income to express the optimization degree of mining industrial structure. The larger the value, the higher the optimization degree of mining industrial structure.

Explanatory variables. Market-driven environmental regulation (MER). Market incentive environmental regulation is based on the law of value, using price, tax, subsidies and other market economic means to encourage enterprises to carry out independent innovation in pollution reduction technology to protect the environment[4]. For mining industry, market incentive environmental regulation measures will directly affect the amount of investment in mine environmental governance. In order to reflect the characteristics of the mining industry, this paper uses Gaowei's method to measure the intensity of market incentive environmental regulation by the ratio of the investment in mine environmental treatment in this year to the total investment in environmental pollution treatment in this year. The larger the ratio, the higher the proportion of mine environmental governance and restoration costs, and the greater the intensity of market incentive environmental regulation.

Control variables. Technological innovation (TI). Technological innovation can promote enterprises to form core competitiveness and is the fundamental driving force of industrial structure optimization[5]. In this paper, the

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ratio of experimental expenditure to gross regional product is used to express.

Enterprise Access (EA). The intensity of environmental regulation affects the number of mining enterprise access, and the number of enterprise access may affect the optimization of mining industry structure. In this paper, the unit number of mining enterprises above the designated size is used to represent this variable.

Foreign direct investment (FDI). Most researches believe that FDI can introduce advanced production technology and management experience, so as to promote the optimization of industrial structure[6]. In this paper, the foreign direct investment in mining industry is expressed.

Mineral product market demand (MD) [7]. This variable is expressed by the consumption intensity of mineral resources, namely the input of mineral resources products required per unit of GDP output.

Resource endowment (NR). The degree of endowment of mineral resources is expressed by the proportion of fixed asset investment in mining industry to the total investment in fixed assets of the whole society.

The descriptive statistical results of each variable are shown in Table 1. There is a big difference between the maximum value and the minimum value of each variable, which ensures that there is a certain variance change in the study, and provides data support for analyzing the correlation between market incentive environmental regulation and mining industry structure optimization.

Table 1 Descriptive statistics of variables

variable	Mean	Standard deviation	Minimum value	Maximum value
Mining industry structure optimization	0.1483	0.0721	0.0375	0.2559
Market-driven environmental regulation	0.0149	0.0047	0.0084	0.0260
Technological innovation	1.8175	0.2568	1.42	2.13
Foreign direct investment	538511.42	30417.23	9634	130198
Enterprise Access	16342.42	3000.928	11046	20703
Resource endowment	0.0333	0.0103	0.0144	0.0446
Mineral product market demand	0.0994	0.0237	0.0575	0.1294

2.2.Model Setting

This paper selects panel data regression model to study the impact of market-incentive environmental regulation on the mining industry structure, and uses stata15.0 software to conduct regression analysis on the provincial panel data of 30 provinces (autonomous regions) from 2006 to 2017, excluding Xizang. Referring to the existing literature, with the optimization of mining industry structure as the explained variable and market incentive environmental regulation as the explanatory variable, five control variables were selected to establish the following econometric model:

$$\mathrm{MISO}_{it} = \beta_0 + \beta_1\mathrm{MER}_{it} + \beta_2\mathrm{MER}_{it}^2 + \beta_3\mathrm{TI}_{it} + \beta_4\mathrm{FDI}_{it} + \beta_5\mathrm{EA}_{it} + \beta_6\mathrm{NR}_{it} + \beta_7\mathrm{MD}_{it} + \varepsilon_{it}$$

In the above model, i is the province (i= 1,2... , 30),t is time (t= 1,2... , 12),ε is a random error term.

3. Correlation analysis

Pearson correlation coefficient was used in this paper to analyze the correlation between the two variables. It can be seen from the correlation analysis table of each variable (see Table 2) that there is a correlation between the explanatory variable (MER) and the explained variable (MISO), and further regression analysis is necessary.

Table 2 Correlation analysis of variables

	MISO	MER	TI	FDI	EA	NR	MD
MIS	1						
MER	0.630**	1					
TI	-0.119	-0.12	1				
FDI	-0.068	-0.074	-0.073	1			
EA	-	-0.03	-0.045	0.034	1		
NR	-	-	-	-0.076	0.081	1	
MD	0.278**	0.11	-0.177*	-0.026	-0.275**	0.700**	1

note: *p＜0.05，** p＜0.01，*** p＜0.001

4. Analysis of regression results at the national overall level

In this paper, the fixed effects model (FE) and the random effects model (RE) were compared by the Hausmann test. The results showed that the P value was 0.0581, which was greater than the given significance level of 0.05, meeting the application conditions of the random effects model. Therefore, the random effect model is obviously better than the fixed effect model.

RE results of the random effects model show that: R-squared is 0.4190, 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 Wald chi2 value of the model is 74.99, and the corresponding P value is 0. Therefore, it is considered that the model as a whole is significant, that is, the coefficients of each variable of the model are not all 0. Finally, the coefficient T-test showed that the coefficients of MER and NR were both lower than the significance level of 5%. Therefore, it is believed that MER and NR have significant effects on MISO.

The impact of market incentive environmental regulation on the structure of Chinese mining industry is shown in the following table (see Table 3) : The primary coefficient of market incentive environmental regulation is 0.817, which passes the significance test of 1%. The results show that when the intensity of market incentive environmental regulation increases by 1%, the adjustment degree of mining industrial structure increases by 0.817%, and there is a linear relationship between market incentive environmental regulation and the adjustment of mining industrial structure. Among the control variables, technological innovation and market demand have significant positive effects on the optimization of mining industry structure. Mineral resource endowment can produce significant negative effect; Foreign direct investment and the entry of mining companies have not

had a significant impact.

Table 3 Regression analysis results of the impact of market incentive environmental regulation on the national mining industry structure

	FE	RE
VARIABLES	MISO	MISO
MER	0.722*** (3.305)	0.817*** (3.726)
MER^2		
TI	0.381.*** (0.292)	0.689* (0.164)
FDI	-1.64e-07 (-1.724)	-9.74e-08 (-1.018)
EA	-4.51e-05 (-0.922)	-5.86e-05 (-1.506)
NR	-0.600*** (-0.265)	-0.791*** (-0.353)
MD	0.437*** (2.943)	0.237** (1.823)
Constant	0.161** (2.353)	0.124** (2.224)
Observations	360	360
R-squared	0.446	0.4190
Number of code	30	30
F	13.98	
Wald chi2		74.99
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)

10.68

Prob>chi2 = 0.0581

(V_b-V_B is not positive definite

5. Heterogeneity analysis based on regional level

In this paper, the fixed effects model (FE) and the random effects model (RE) were compared by the Hausmann test. The results show that the P value in the eastern region is 0.0597, which is greater than the given significance level of 0.05, meeting the application conditions of the random effects model. Therefore, the random effect model is obviously better than the fixed effect model. The random effects model RE was applied to the data in the eastern region, and the results showed that R-squared was 0.4211, the goodness of fit of the model was moderate, and the independent variables of the model could explain most of the information of the dependent variables. The Wald chi2 value of the model is 74.87, and the corresponding P value is 0. Therefore, it is considered that the model as a whole is significant, that is, the coefficients of each variable of the model are not all 0. The same procedure is used to compare and test the data in the central and western regions, and the results show that the random effects model is also applicable.

The regression analysis results of the impact of market incentive environmental regulation on the mining industry structure in eastern and central and western regions are shown in the following table (see Table 4).In the eastern region, the coefficient of market incentive environmental regulation is 0.895, which is significant at the level of 1%. It shows that the market incentive environmental regulation plays a positive role in promoting the adjustment of the mining industry structure in the eastern region, which is consistent with the conclusion based on the regression analysis of national samples. In the central and western regions, the coefficient of market incentive environmental regulation is 0.798, but it is not significant, which is not consistent with the conclusion at the national level.

Table 4 Regression analysis results of the impact of market incentive environmental regulation on mining industry structure in different regions

	Eastern region	Central and western regions
	RE	RE
VARIABLES	MISO	MISO
MER	0.895*** (3.422)	0.798 (3.616)
MER^2	—	—
TI	0.733*** (0.241)	0.525* (0.179)
FDI	-1.56e-03 (-1.627)	-7.04e-06 (-1.219)
EA	-3.99e-04 (-0.949)	-5.76e-01 (-1.308)
NR	0.523*** (0.251)	-0.851*** (-0.372)
MD	0.416*** (2.957)	0.195** (1.625)
Constant	0.167** (2.349)	0.126** (2.235)
Observations	360	360
R-squared	0.446	0.4190
Number of code	30	30
F	13.98	
Wald chi2		74.99
Prob	0.0000	0.0000

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

6. Conclusion and Enlightenment

According to the results of regression analysis, the following conclusions can be drawn: the market incentive environmental regulation in the form of pollutant discharge taxes, subsidies and other forms plays a positive role in technology development, technology transformation, green process innovation and green product innovation, and thus promotes the optimization of the mining industry structure; The influence of environmental regulation on the adjustment of mining industry structure in different regions has certain regional heterogeneity.

Based on the above conclusions, the implications of this study are as follows:

Give full play to the role of incentive environmental regulation and guide enterprises to transform and upgrade

independently[8]. By means of finance, taxation, emission rights trading, deposit system and extension of producer responsibility, price signals, competition mechanism and laws of supply and demand in the environmental protection market are used to encourage enterprises to comply with environmental protection laws and regulations, guide their production decision-making behavior, and promote their unconscious participation in promoting environmental governance and industrial structure adjustment[9].

Implementing differentiated environmental regulation policies.In view of the different effects of market incentive environmental regulation on the structural adjustment of mining industry in eastern and central and western regions, regional differentiated environmental regulation policies should be implemented[10]. Regional environmental regulation policy should strengthen the connection with regional industrial policy. The formulation of regional industrial policies should conform to the requirements of regional environmental regulation policies. The regional environmental regulation policies should determine the focus and direction of environmental regulation according to the bearing conditions of regional resources and environment and the actual development of regional economy.

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