Analysis of the Efficiency of Environmental Regulation on the Transformation of the Resource-based Cities

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Abstract. The transformation of resource-based cities is mainly to reduce the energy consumption of industrial enterprises, improve the ecological environment, adjust the industrial structure, and solves the problem about using a single industry as the main industry of the city. Based on the panel data of 111 resource cities in China from 2006 to 2017, this paper uses panel threshold regression method to study the impact of environmental regulation on resource-based urban transformation. The results show that environmental regulation has a significant single-threshold effect on industrial energy consumption, but environmental regulation has a significant linear relationship with industrial structure adjustment. The increase in the intensity of environmental regulation can effectively reduce the use of industrial energy consumption, while promoting the rationalization of urban industrial structure. The government can increase the degree of environmental regulation, increase market openness and increase investment scale to improve the efficiency of resource-based urban transformation.

Keywords: Environmental regulation, industrial structure, industrial energy consumption, resource-based city

1. Introduction

Resource-based cities are cities with high resource endowments and resource dependence, and the exploitation and processing of resources as the leading industries for regional urban development. Ever since a long time ago, through the continuous exploitation of its own resources to transport raw city construction materials, in the process of China's continuous economic development, resource-based cities play a key role in promoting. However, due to the lack of overall planning and the resource depletion, the resource-based cities gradually exposed serious problems During mining. In 2007, in order to make the resource-based cities sustainable development, the General Office of the State Council of the People's Republic of China issued relevant opinions and explanations to ensure the sustainable development of resource-based cities, which suggested that governments at all levels should guide and regulate industrial enterprises to undertake resource consumption compensation and ecological environment restoration. The responsibility of the resource city makes rational use of existing resources, reduce resource consumption, maintain sustainable environmental development, and adjust the industrial structure, so that the city will change in another direction.
The contents of the literature involved mainly include the following aspects: (1) The impact of environmental regulations on industrial energy consumption. In a paper published by Wang Xueyuan and others in 2019, the environmental regulations are divided into the following two categories: one is cost regulation and the other is investment regulation. Cost-based environmental regulation increases the production costs of industrial enterprises directly in the short term, driving enterprises to increase investment in science and technology and increase productivity. Investing environmental regulation plays an incentive role in corporate pollution control in the long run. Through the re-examination of the "strong porter hypothesis", it is determined that environmental regulation can promote the green productivity of industrial enterprises and reduce energy consumption.\[1\] From another point of view, as government regulations and systems on environmental controls become more stringent, not all industrial enterprises have sufficient capital and resources to invest in R&D. Therefore, some companies will choose to reduce the scale of management innovation and institutional innovation to improve organizational efficiency and energy efficiency. (2) The impact of the increasingly strict environmental system on industrial restructuring. Combined with current relevant research literature, it can be found that most scholars believe that environmental regulation plays an important role in the structure adjustment of urban energy consumption and industrial structure. "follow the cost theory." Strict environmental regulation embodies the negative externalities brought about by pollution, enterprise production costs are also included.\[2\] Reducing the production efficiency of enterprises and reducing profits. This will cause some enterprises with high pollution and low efficiency to adjust scale and upgrade technology. Or exiting the market to redistribute resources and affect resource depletion and industry structure. Under this hypothesis, Li Hong et al. (2018) clearly mentioned in the published paper that the environmental regulations and rules play a significant threshold effect in the process of rationalizing and upgrading the industry. The adjustment of the industrial structure and the development of the industry will improve with the environmental system which became more optimized.

The impact of environmental regulation on urban transformation mainly considers three aspects of ecological development, industrial consumption and industrial structure adjustment. Combined with the results of the current study, existing researches are mostly conducted on provincial, specific cities, municipal and autonomous regions.\[3\] Detailed analysis is carried out in prefecture-level cities, while the resource-based cities need to adjust industrial structure more and complete urban transformation. Secondly, the transformation of the resource-based cities is not only the adjustment of industrial structure, also existing literature is to make the industrial structure more reasonable and advanced. As a kind of transformation indicator, it ignores whether the situation of resource depletion in the process of resource city transformation has improved, and in the process of urban development and transformation, the urban ecological environment is also constantly being restored. From other aspects, the indicators used in the impact of environmental regulation on industrial transformation and upgrading are different. Most of them are based on the method to construct indicators based on the degree of industrial deviation or the Tyre index. This paper believes that it can be more perfect. The Author will further study the impact of environmental regulations on ecological development and the extent to which different resource cities are affected by environmental regulations.\[4\] Therefore, this paper uses the data of 111 resource cities in 2006-2017 to analyze the effect of environmental regulation on the resource-based city transformation by panel regression analysis. Because the difference in the degree of environmental regulation will promote the timely adjustment of the optimal production mode, according to the hypotheses, it can be seen that the impact of environmental regulation on the enterprise depends on the degree of accumulation of environmental regulation, and it cannot reflect the environmental regulation through a single linear relationship. In this research, the author mainly adopts this research method to build the environmental system rules and regulations based on the pollution index. and as a threshold variable, verifies whether there is a threshold effect between analytical environmental regulation and industrial structure adjustment and industrial energy consumption, and obtains the specific number of thresholds and variables.
2. Model Construction

2.1. Measurement Model Construction
This paper focuses on the impact of environmental regulation on resource consumption and industrial transformation. The model is:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln ER_{it} + \beta_2 \ln X + \epsilon_{it} \quad (1)$$

$Y$ represents two explanatory variables - energy consumption per unit of GDP and rationalization of industrial structure. Represents the strict level of environmental rules and regulations corresponding to urban areas. $X$ indicates other control variables. The main reason is that there is a very close relationship between the strictness of environmental supervision and GDP per capita. an interaction term between the degree of environmental regulation and gdp per capita is added to the model. Therefore, the natural logarithmic form is adopted for variable data. The main purpose is to reduce the heteroscedasticity between the data.

$$\ln Y_{it} = \beta_0 + \beta_1 \ln ER_{it} + \beta_2 \ln X + \beta_3 (\ln ER_{it} * \ln PG_{it}) + \epsilon_{it} \quad (2)$$

For this fixed-effect model, environmental regulation has a significant linear effect on the rationalization of industrial structure and industrial energy consumption. But, environmental supervision is always a comprehensive indicator, and the impact on energy consumption and industrial structure is also multifaceted. In order to test whether there is a nonlinear relationship between variables, the above-mentioned nonlinear relationship is tested by the panel threshold regression model proposed by Hansen (1999). Setting environmental regulations as threshold variables, and the threshold is estimated based on the sample data, and whether the influence of the two groups before and after the threshold is grouped is significant. The panel threshold regression model built in this article is as follows:

$$\ln EPG = \beta_0 + \beta_1 \ln er * I(\ln er \leq \gamma) + \beta_2 \ln er * I(\ln er < \gamma) + \alpha_1 \ln X + \mu_1 \quad (3)$$

$$\ln RIS = \lambda_0 + \lambda_1 \ln er * I(\ln er \leq \delta) + \lambda_2 \ln er * I(\ln er < \delta) + \alpha_2 \ln X + \mu_2 \quad (4)$$

Among them, 1 (·) representative function, when the expression in parentheses does not hold, 0 when the value is set, or 1 if not. Adjust the environment by referring to the threshold variable. whether $\ln ER$ is greater than $\gamma$, $\delta$, the sample interval can be divided, and the number of divided regions is 2, and the regions are divided according to the difference of the slope value. $X$ stands for control variable, including: investment size $IL$, degree of openness $EO$, level of economic development $PG$, and government intervention. Because the number of thresholds cannot be determined, a two-threshold and three-threshold model is established, as follows:

$$\ln EPG = \beta_0 + \beta_1 \ln er * I(\ln er \leq \gamma_1) + \beta_2 \ln er * I(\gamma_1 < \ln er \geq \gamma_2) + \beta_3 \ln er * I(\gamma_2 < \ln er) + \alpha_1 \ln X + \mu_1$$

$$\ln RIS = \lambda_0 + \lambda_1 \ln er * I(\ln er \leq \delta_1) + \lambda_2 \ln er * I(\delta_1 < \ln er \leq \delta_2) + \lambda_3 \ln er * I(\delta_2 < \ln er) + \alpha_2 \ln X + \mu_2$$

2.2. Explained Variable
(1) The energy consumption per unit of GDP directly reflects the dependence of national or regional economic development on energy, and indirectly reflects the effects of various energy conservation policies and measures, and testing actual results after energy saving measures. Due to the different resources enriched by each resource city, it is impossible to calculate from the comprehensive energy consumption. In this paper, the unit GDP power consumption is used to replace the unit GDP energy
consumption, and the industrial power supply is selected to replace the total regional electricity consumption. The total industrial output value is used to replace the regional GDP analysis to eliminate the impact of domestic electricity consumption. Energy consumption per unit of output (EPG) = industrial electricity consumption / total industrial output value.

(2) The adjustment of the industrial structure is mainly based on the upgrading of the industrial structure and the rationalization of industrial integration. The rationalization of industrial structure is a process of strengthening coordination between industries and improving the level of association. The basis of measurement is whether the development of industry is coordinated and whether the realization of factor resources is effective. Configuration. This paper draws on Zhang Lin's (2016) method to improve the measurement indicators based on the comprehensive consideration of the industrial structure deviation coefficient and the Thai index measurement method. Refer to the following formula for reference:

\[ RIS = \sum_{i=1}^{s} \left( \frac{Y_i}{Y} \right) \sqrt{\frac{Y_i / E_i}{Y / E} - 1} \]  

(7)

2.3. Explanatory Variable

There are generally two methods for setting environmental regulation indicators, one is a single indicator and the other is a comprehensive indicator. A single indicator is generally measured by the ratio of the amount of environmental governance investment to the regional GDP of the region in the same year (Zhang Cheng et al., 2011). The comprehensive index calculation adopts the entropy method. For example, Combining "three industrial wastes" into environmental pollution index, and combined the production technology into the resource-based urban transformation performance index model (Dong Feng et al. 2013). Based on the practice of Zhao Yuwei (2014), this paper selects the reciprocal of the environmental pollution index derived from the combination of industrial wastewater, industrial SO2 and industrial smoke (powder) dust to measure the degree of environmental regulation. Refer to the following formula for reference:

\[ ER_{i,t} = \frac{1}{(\sum_{i=1}^{s} \frac{E_{i,t}}{Y_{i,t}})} \]  

(8)

2.4. Control Variables

According to the overall regional fixed asset investment, Henry is targeted at the investment scale (IL). Industrial policies, especially industrial policies, have a significant impact on the industrial structure of the entire region. Since economic policies have more direct and effective interventions for state-owned enterprises, the greater the proportion of Chinese enterprises in a certain industry, then the impact of government intervention becomes more apparent. The opposite is weaker. The indicators of government intervention mainly include Fan Gang's marketization index, labor mobility control, the proportion of state-owned enterprise assets, and the proportion of government expenditures. The article uses “urban private and individual employees”. Proportion of government employees measures the extent of government intervention. The greater the value of this indicator, then the development status of cities in the private economy is becoming more active; GDPP is measured by per capita actual GRP; regional openness (EO) By using trade openness, after the implementation of free trade, there will be differences in the products produced by specialization in different countries, which may lead to the redistribution of industries among different countries on a global scale. Even if the industrial upgrading policy has not been implemented, the implementation of China's reform and opening-up policy has a very significant impact on national industrial upgrading and industrial transformation.

Multiple regression methods are often applied when analyzing the quantitative relationship between variables. Including a random effects model a mixed regression, a fixed effect model and then selected
by LM test and Hausman test. At the same time, the purpose is to reduce the heteroscedasticity of the data, when the regression is performed on (1), variables take the form of natural logarithms.

3. Analysis of Result

3.1. Analysis of Regression Results

The main research object of this article is resource-based cities. we can see that the adjoint probability corresponding to the LM test is 0.0000. Therefore, between the “mixed regression” and “random effect” models, the model that should be chosen is the "random effect model". According to Hausman's test, the adjoint probability is 0.000000, so the "fixed effect model" should be used between the "fixed effect" and "random effect" models. In summary, the “fixed effect model (FE)” should be used for analysis at this time.

When the explanatory variable is lnEPG, at the same time because of the side effects of regional economic development. lnER has a greater negative impact on energy consumption. For regional economic development areas, as the corresponding environmental regulations and policies become more stringent, the use of industrial energy by resource-based cities will increase. The less. At the same time, the more fixed investment is introduced, the less the use of industrial energy consumption will be promoted; the degree of government intervention InDGI and regional openness InEO have no significant impact on industrial energy consumption, indicating the distribution of enterprise type structure and the cooperation investment of foreign-funded enterprises. There is no significant impact on the change in energy consumption in cities.

When the explanatory variable is lnRIS, due to the role of regional economic development level, For the rationalization of the industrial structure, lnER has a greater negative impact on energy consumption. lnER can have a very positive and positive impact, and can improve the strict level of environmental regulations. It will have a positive effect on the rationality of the industrial structure, and it will also have a very significant positive impact on regional economic development. From a regional perspective, the adjustment in industrial structure will be very significant. Both fixed investment and GDP per capita have a significant positive impact on the rationalization of industrial structure.[5] These data show that the larger the investment scale, when the stability of the region in terms of economic development is higher, the rationality of the regional industrial structure will be higher. However, the combined impact of environmental regulations and per capita GDP has a negative impact on the adjustment of the industrial structure. However, the degree of openness of development policies in a region will have a very positive and positive impact on the industrial structure, and free trade helps to adjust the industrial structure of resource-based cities. Regarding the impact of industrial structure rationalization, the impact of government intervention in policy is not obvious, indicating that the distribution of enterprise types has no direct impact on the adjustment of urban industrial structure.

3.2. Analysis of Threshold Regression

The two thresholds are estimated with the first threshold fixed. Taking industrial industrial energy consumption lnepg industrial structure rationalization lnRIS as the explanatory variable, we estimate the threshold, two thresholds and three thresholds of environmental regulation lnER in 111 resource-based cities, and draw on Hansen's (self-help method). Bootstrap), by repeatedly sampling 300 times to obtain the P value corresponding to the test statistic, its main purpose is to verify the possibility of threshold effects, the following is the analysis result of the threshold regression.

With lnER as the threshold variable, it can be found that when the interpreted variable is industrial energy consumption, the P value is less than 0.1 under a threshold model, indicating that the threshold value of a threshold model passes the test. Then reject the null hypothesis for the second and third thresholds. If the industrial structure is the target of the research, the null hypothesis cannot be rejected, so the threshold effect does not exist.

Analysis of the deep-seated reasons, the degree of environmental regulation will influence the migration of enterprises and the upgrading of internal technology, technology upgrade will reduce the
use of energy consumption, at the same time, corporate migration can have a very significant impact and change on the urban industrial structure. If the environmental regulations reach a certain level, the degree of impact on industrial energy consumption will decrease, but the process of industrial structure adjustment and technological upgrade will have a greater impact on industrial energy consumption.

In summary, environmental regulations will have a significant impact on urban resource-based cities. Compared with non-resource cities, resource-based cities will have more advantages in terms of industrial development. The total industrial output value accounts for the vast majority of urban economic development. Through pollution management, it can be effectively adjusted. The production efficiency of industrial enterprises and the increase of production costs will cause many enterprises to withdraw from the market or be integrated, adjust for urban industrial structure. If environmental regulations are used as threshold variables, and if the degree is continuously increasing, the impact of environmental regulations on industrial energy consumption will obviously exceed the fixed effect model.

4. Conclusion

This article focuses on 111 Chinese resource-based cities from 2006 to 2017, and analyzes the influence of environmental regulation on city development during the transformation of resource-based cities. Using the fixed effect model and the threshold regression method, the internal mechanism of environmental regulation on industrial energy consumption and industrial structure adjustment of resource cities is explored, and the following conclusions can be obtained:

1) The transformation of resource-based cities is mainly through the influence of environmental regulation. Strict environmental regulation is conducive to controlling the use of endowment resources and reducing pollution. Because the production costs continue to rise, more high-quality companies will choose to enter the market, and low-quality companies will choose to exit the market, it will have a significant role in promoting the rationalization of the industrial structure. In these cities, cities with more developed regional economies are more affected by environmental regulations.

2) When industrial energy consumption is the research object. To some extent, the impact of industrial energy consumption from environmental regulations will be very significant. Although it will still exist after exceeding the threshold, the degree of restriction will be reduced. For resource-based cities, as the government's environmental policies and regulations become more stringent, the impact on the regional industrial structure will become more significant. which is more helpful to the industrial diversification of resource cities.

3) For resource-based cities, the degree of development will have a significant impact on development transformation. If cities are higher in terms of economic development, then it will attract more enterprises to enter the market and adjust the industrial structure. Then the proportion of industrial enterprises' contribution to the development of urban economy will gradually decline. The common development of multiple industries will reduce the single industry. The consumption of endowment resources, so industrial energy consumption will decline. The larger the investment scale, when the level of industrial energy consumption is lower, the industrial structure will become more reasonable. Although the impact of regional openness on energy consumption is not obvious, it can promote the rationalization of industrial structure. This shows that the degree of regional openness will introduce more non-industrial enterprises into the local market, but will not be related to the technology and resources of local industrial enterprises. There are restrictions on use. The level of economic development will promote resource-based cities to increase production efficiency, reduce pollution and energy consumption, and rationalize and adjust the industrial structure. The degree of impact of government regulations and policies on industrial structure and energy consumption is not obvious. In the process of resource city transformation, the government needs to strengthen its influence.

Basing on the data analysis, some relevant suggestions can be made:
(1) The transformation of resource-based cities should make full use of environmental regulations. It can alleviate the problem of energy consumption and positively influence the adjustment of the industrial system. The degree of environmental regulation should not be a solidification standard. According to the comprehensive pollution index, it can be seen that the urban pollution degree of different locations and different development levels is large, and the degree of environmental regulation should also be matched with the pollution index to formulate appropriate local development. Policy recommendations.

(2) At the same time, the government should enhance market openness, determine the mode of economic development and the specific direction of development transformation, attract more suitable naive enterprises to invest in the market, and improve the development situation of “one-size production” of resource-based cities. Large local industrial enterprises can speed up technological research and development and improve efficiency. At the same time, they should also increase the use of clean energy and strengthen cooperation with related enterprises. Finally, the government should increase the relevant assessment mechanism to strengthen the government's role in promoting urban transformation.

(3) Under the influence of technological innovation or resource endowment (Zhou Ke, 2019; Li Hong et al., 2018), the policy system will exert a very significant double-threshold effect on the industrial adjusting. Explain that the transformation of resource-based cities can not only rely on environmental regulation to constrain the production of enterprises, but also increase the expenditure of innovation and technology by combining the richness of local resources, attract more high-tech enterprises and service-oriented enterprises to enter the market, and promote the transformation of urban economy.

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