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The Effects of Environmental Regulation on Investment Efficiency—An Empirical Analysis of Manufacturing Firms in the Beijing–Tianjin–Hebei Region, China

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Abstract: The Beijing–Tianjin–Hebei region is China's most important urban economic group. The specific structure of the region's manufacturing industry causes enterprises to face the problem of low investment efficiency. How to balance high efficiency investment with the development of the ecological environment, achieving a win–win situation, is an urgent problem. In order to explore the impact of environmental regulation on the investment efficiency of listed manufacturing enterprises in the Beijing–Tianjin–Hebei region, this study utilized environmental regulation and enterprise-level data from 2011 to 2017, established a panel regression model, and then tested the impact mechanism of environmental regulation on corporate investment efficiency. On this basis, the panel threshold model was established to test the existence of the threshold effect of environmental regulation. The empirical results show that environmental regulation will have a negative impact on the investment efficiency of the listed manufacturing companies in the Beijing–Tianjin–Hebei region, causing the threshold of the impact of environmental regulation on investment efficiency to move from promotion to suppression. Finally, in accordance with the different scopes of the environmental regulation intensity of each manufacturing industry, the paper proposes reasonable suggestions for government departments in order to formulate environmental policies to improve the efficiency of enterprise investment.

Keywords: environmental regulations; investment efficiency; Beijing–Tianjin–Hebei region; panel threshold model; manufacturing firm

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1. Introduction

In recent years, China's macro economy has improved steadily. As one of the three pillars of the national economy, investment is undoubtedly an important factor leading to economic growth [1]. The efficiency of investment is also regarded as one of the key factors to evaluate a country's economic development. From the micro point of view, investment efficiency also plays a decisive role in the profitability and enterprise value of enterprises [2,3]. When investing, enterprises will consume a large amount of resources, and discharge pollutants in the expansion of reproduction. If the pollutants are not properly treated, they will inevitably have a negative impact on aspects of the ecological environment, such as the atmosphere and water resources, and then affect the cycle development of the whole macro economy in the long run [4]. At present, the deterioration of the ecological environment and serious environmental pollution in China largely stem from the imbalance between Chinese enterprises' development and environmental protection in the process of investment and production, and a failure to find methods of green investment [5,6]. In order to seek a balance between the steady growth of the national economy and the development of the ecological environment, and in order to achieve a win–win situation for both the economy and environmental protection, the Chinese government has implemented various environmental regulation policies. The "Porter Hypothesis" holds that if environmental regulation can be properly designed, it can stimulate the potential for technological innovation and green production capacity of enterprises to a certain extent and make up for the extra governance costs brought about by environmental regulation in part or even in whole, optimizing the allocation of enterprises' resources and leading to technological innovation. It will bring competitive advantages to enterprises and improve investment efficiency and production competitiveness [7]. However, some scholars believe that environmental regulation can lead to the excessive investment of enterprises and reduce investment efficiency. The strengthening of environmental regulation for China's Beijing–Tianjin–Hebei region, which is dominated by "command-control" tools, and the policy of eliminating backward production capacity, formulated to achieve the goal of energy conservation and emission reduction, will lead enterprises to continuously expand their investment expenditure and raise the scale of investment, resulting in excessive investment [7,8]. On the other hand, environmental regulation may induce the insufficient investment of enterprises. Firstly, the uncertain economic consequences caused by environmental regulation will increase the option value of investment opportunities and lead to enterprises reducing or delaying investment. Secondly, with the increasingly limited environmental capacity for new investment in various regions, it will also impose certain constraints on the investment behavior of enterprises, resulting in insufficient investment [7,9].

In this context, it has become an important topic of research to explore how environmental regulation affects the investment efficiency of enterprises, and whether it can coordinate the unbalanced relationship between environment and economy and realize the healthy development of both on the basis of reasonably dealing with environmental regulation and improving pollution prevention and control. Therefore, this study mainly focuses on the following two research questions:

1. What is the effect of environmental regulation on the investment efficiency of listed manufacturing companies in the Beijing–Tianjin–Hebei region?
2. What is the impact mechanism of environmental regulation on the investment efficiency of listed manufacturing companies in the Beijing–Tianjin–Hebei region?

With the help of the threshold panel regression model in sampling endogenous grouping, through theoretical analysis and empirical modeling, we aim to explore the research questions above in order to provide a theoretical basis for constructive suggestions for the government of Beijing, Tianjin, and Hebei, in order to formulate environmental policies. Our results can be used by enterprises to reasonably deal with environmental regulation, promote their own development, and compensate for the lack of relevant research in the field of enterprise investment efficiency.

2. Case Overview

As a representative region of China's heavy industry development, the Beijing–Tianjin–Hebei region has been in a leading position in the development of its manufacturing industry due to specific historical reasons and superior geographical location, as well as the strong developmental foundation of the manufacturing industry. The 2008 to 2018 statistical yearbook shows that the total industrial output value above the designated size in the Beijing–Tianjin–Hebei region continues to grow; coupled with the favorable policies issued by the government in recent years, the manufacturing industry in the Beijing–Tianjin–Hebei region is exhibiting stable and healthy development [10,11].

It is worth noting that manufacturing in the Beijing–Tianjin–Hebei region has been at the lower end of the value chain on the whole. The resource- and labor-intensive traditional manufacturing industry has developed faster, due to the low cost of resources and labor. The subsequent problem is that the Beijing–Tianjin–Hebei region manufacturing enterprise investment efficiency is low, generally demonstrating inefficient investment. However, with the increasingly prominent contradiction between environmental problems and economic development, as well as the rapid consumption of resources and the continuous rise of labor costs in China, the competitive advantage of traditional manufacturing in the Beijing–Tianjin–Hebei region is being gradually weakened and needs to be transformed and upgraded. The contradiction between industrial development and environmental protection also needs to be alleviated [12].

At present, the overall development of China's environmental regulations shows a trend of gradual improvement. In recent years, the Chinese government has issued a series of environmental governance policies, such as the Environmental Protection Tax Law of the People's Republic of China (2018), the catalogue of classified management of pollutant discharge permits from fixed pollution sources (2017 edition), and the Law of the People's Republic of China on the prevention and control of air pollution (2016), etc. The promulgation and implementation of these policies and regulations have clarified the significance of the environmental protection functions and the scope of the authority of the central government and governments at all levels in the environmental governance system, as well as the plan to reform China's environmental protection system in the future [13]. For the Beijing–Tianjin–Hebei region, the level of environmental regulation has been continuously improving in recent years and is at a high level across the country. The government has introduced a series of environmental systems for the Beijing–Tianjin–Hebei region, for example, the action plan for the comprehensive treatment of air pollution in autumn and winter 2018–2019 in Beijing–Tianjin–Hebei and its surrounding areas (2018), the work plan for the prevention and control of air pollution in 2017 in Beijing–Tianjin–Hebei and its surrounding areas (2017), and the ecological environment protection plan for the coordinated development of Beijing–Tianjin–Hebei (2015) [14]. However, the environmental quality of the Beijing–Tianjin–Hebei region has not been much improved in recent years, potentially because environmental regulation policies do not adapt well to the survival mode of enterprises in the region, and targeted environmental regulation policies cannot be formulated according to the characteristics of various industries [15].

3. Literature Review

3.1. Relationship between Environmental Regulation and Enterprise Investment

The theoretical basis of environmental regulation comes from Pigou's externality theory. Market failure caused by externality is the main reason for the existence of environmental regulation. In the process of economic development, the problems of damage and pollution to the ecological environment cannot be solved by the market itself. Only by the intervention of the government can we solve the problem of the failure of the market mechanism. At present, there is no consistent view of the impact of environmental regulation on enterprise investment efficiency. As enterprises face strict environmental supervision, in order to reduce the environmental pollution generated by their business activities to comply with environmental regulations and reduce compliance costs, enterprises will adopt strategic planning (Sharma, 2000) [16]. Paulsson (2004) studied the impact of the uncertainty of environmental regulation on the change in enterprise behavior and found that when environmental policy change is high risk, the enterprise will take the initiative to withdraw from the market in order to avoid the risk or choose to invest when the external policy tends towards being stable [17]. Isabelle Piot-Lepetit and Monique Le Moing (2007) [18] found that after the introduction of European agricultural pollution water laws and regulations in France, enterprises were forced to innovate in technology, realizing the "win-win" of economic green transformation, environmental regulation, and productivity. Chintrakam (2008) took the American economy as a research sample and believed that environmental regulation would change the original production technology and production process of enterprises, resulting in additional production costs and ultimately reducing their own productivity [19]. Stoever, J. (2018) found that relevant regulations showed no signs of affecting the company's economic performance [20]. Andrea et al. (2011) [21] found that environmental regulation will promote enterprises to increase various investment scales in production and operation, but the growth rate of enterprise investment will decline. At the same time, the flexible formulation of environmental regulation policies can give enterprises a certain degree of innovation freedom, so as to stimulate the innovative production potential of enterprises to improve financial performance (Ramanathan et al., 2018) [22]. Song, H.X. (2016) [23] found that environmental regulation has a weakening effect on the sensitivity of enterprise investment opportunities and investment expenditure, and environmental regulation provides potential opportunities for enterprise technological innovation.

Other scholars have studied the behavior of enterprises in production and environmental protection investment and R&D innovation in the face of environmental regulation. Garcia-Quevedo (2021) [24] found that different environmental policies and measures have different effects on energy efficiency investment. Pandej Chintrakarn (2008) [19] used the data of 48 states in the United States to prove that environmental strictness has a significant positive impact on the low technical efficiency of states in the United States. Wu, F. et al. (2018) [25] and Zhang, J. (2016) [26] proposed that environmental regulation of different intensity is two-way for enterprises' decision-making and investment behavior. When the regulatory policies formulated by the environmental regulatory authorities are not effective or their implementation is not strict, enterprises will weigh the administrative penalties paid to the environmental protection authorities and the benefits brought by other non-environmental investment with the cost of pollution control for the sake of maximizing their own interests, thus preferring other investments to pollution control and environmental protection. Yao, D. et al. (2018) [27] and Feng, Z.J. et al. (2018) [28] adopted the intermediary test model and introduced two intermediary variables: enterprise investment opportunities and technological innovation. The study found that environmental regulation improved the investment efficiency of enterprises and reduced the investment opportunities of enterprises, proving the "Porter Hypothesis". Jaffe and Palmer (1997) [29] divided "Porter Hypothesis" into "weak Porter Hypothesis" and "strong Porter Hypothesis". They take the American manufacturing industry as the research sample and find that there is a significant positive impact between environmental regulation and enterprise R & D expenditure. In terms of proving the "weak Porter Hypothesis", Brunnermeier and Cohen (2003) [30] calculated that there was a small but statistically significant positive correlation between the cost of pollution control and the number of environmental patents by using more than 140 manufacturing enterprises in the United States as research samples. In terms of proving the "strong Porter Hypothesis", Hamamoto (2006) [31] took the Japanese manufacturing industry as the research object and found that the intensity of environmental regulation significantly improved the productivity of the manufacturing industry. Pan, X.F. and Ai, B.W. (2019) [32] studied the internal dynamic relationship between environmental regulation, technological innovation, and energy efficiency, and found that market incentive environmental regulation can trigger the technological innovation of enterprises and improve energy efficiency. Yang, Y.L. et al. [33] empirically studied the long- and short-term effects of environmental regulation on the level of the green total factor productivity of industrial enterprises. Environmental regulation has a positive effect on green total factor productivity on the whole, which verifies the establishment of the "Porter Hypothesis". Zhou, H.N. (2019) [34] studied the impact of the environmental policies of listed companies in heavy pollution industries in Shanghai and Shenzhen on environmental protection investment and found that the constraints of environmental policies can promote the scale of the environmental protection investment of enterprises. Wang, X.H. et al. (2020) [35] believe that environmental regulation policies have an inhibitory effect on enterprise investment efficiency, in which government subsidies can inhibit enterprises from overinvestment and reduce the degree of underinvestment. Li Tao (2021) [36] believes that environmental regulation policy can promote the investment efficiency of enterprises, which is mainly reflected in the fact that when enterprises overinvest, environmental regulation policy can significantly improve the investment efficiency of enterprises.

For the Beijing–Tianjin–Hebei region, manufacturing industries in this region are mainly resource-intensive and labor-intensive enterprises. Furthermore, the potential of green innovation in production is relatively limited, and the ability to mobilize the enthusiasm of enterprises for green production is not strong in areas such as the policy of eliminating the backward production capacity formulated to achieve the goals of energy conservation and emission reduction. The policy has a very obvious fixed asset scale orientation, which leads enterprises to continuously expand investment expenditure and raise the investment scale, which leads to excessive investment and reduced investment efficiency. Secondly, environmental regulation will significantly increase the environmental investment expenditure and pollution control cost of enterprises. For example, in order to meet the policy requirements of environmental regulation, enterprises will be forced to pay costs relating to pollution reduction and emission reduction, purchasing equipment for pollution control and environmental protection, and fines for illegal practices. These additional expenses caused by environmental regulation may use the investment resources of enterprises and lead to inefficient investment. Based on the above analysis, combined with the industrial characteristics of manufacturing enterprises in the Beijing–Tianjin–Hebei region and the characteristics of environmental regulation policies in this region, we believe that the role of environmental regulation in promoting the investment efficiency of enterprises in the Beijing–Tianjin–Hebei region is not significant, and thus propose research Hypothesis 1.

Hypothesis 1. *Environmental regulation will have a certain negative impact on the investment efficiency of listed manufacturing companies in the Beijing–Tianjin–Hebei.*

3.2. Research on the Threshold Effect of Environmental Regulation

The threshold effect refers to the phenomenon in which when an economic parameter reaches a specific value, another economic parameter suddenly turns to other forms of development. It is common in the field of environmental research. Scholars both domestic and overseas have studied the threshold effect of environmental factors from multiple perspectives, mainly including technological innovation, total factor productivity, environmental protection investment, and carbon emissions. In the literature on environmental regulation and enterprise investment efficiency, although the selection of various research indicators is different and the final results are also different, most of the research results show that the impact of environmental regulation on enterprise investment and production is the result of the comprehensive comparison of positive and negative effects.

According to Porter's Hypothesis, only a proper degree of environmental regulation can promote the technological innovation and the improvement of the production level of the enterprise, and too low and too high levels of environmental regulation are not conducive to the production decision-making of the enterprise. Shen, N. (2012) [37] discussed the threshold effect of environmental regulation on technological innovation. He pointed out that the intensity of environmental regulation and technological innovation are nonlinear. When the intensity of environmental regulation is below a threshold, the elasticity coefficient of environmental regulation to technological innovation is significantly negative. On the contrary, when the intensity of environmental regulation exceeds the threshold, it can significantly promote technological innovation. Su, H. (2018) [38] studied the impact of environmental regulation on the scale and efficiency of enterprise environmental protection investment. The conclusion shows that environmental regulation has a "U-shaped" relationship with the scale of enterprise environmental protection investment and an "inverted U-shaped" relationship with the efficiency. Conrad (1995) [39] and Lanoie and Patry (2008) [40] found that the economic effect of environmental regulation may not be linear. Due to the regional gap, time gap and industrial gap in the economic effect of environmental regulation, it is difficult to determine the size of "compliance cost" and "innovation compensation". Pang, M.C., and Ning, F.X. (2022) [41] found that when the environmental regulation is at an appropriate level, the increase of local government investment intensity can improve the resource mismatch, while when the environmental regulation intensity is too high, the increase of local government investment intensity will aggravate the resource mismatch. Song, W.Y., and Han, W.H (2021) [42] found that both formal and informal environmental regulation can significantly promote the upgrading of industrial structure. However, excessive environmental regulation will weaken the promotion effect of OFDI on the upgrading of industrial structure, and, in this process, environmental regulation has a significant single threshold effect.

In the literature of environmental regulation and enterprise investment efficiency, although the selection of various research indicators is different and the final results are also different, most of the research results show that the impact of environmental regulation on enterprise investment and production is a comprehensive comparison of positive and negative effects. When the regulatory authorities continue to improve the level of administrative control, the amount of penalties paid by enterprises in violation of laws and regulations is higher than the income brought by their investment, so enterprises will fulfill the requirements of environmental regulation, invest funds to control environmental pollution, or upgrade production technology. Based on the above analysis, this paper proposes the second research hypothesis:

Hypothesis 2. *There is a nonlinear threshold effect on the impact of environmental regulation intensity on enterprise investment efficiency, that is, there is a threshold value in the intensity of environmental regulation, which makes a significant difference in the direction or degree of its impact on enterprise investment efficiency.*

4. Methodology

4.1. Research Design

This paper will test the two hypotheses through a panel regression model and a panel threshold model. Research design is shown in Figure 1.

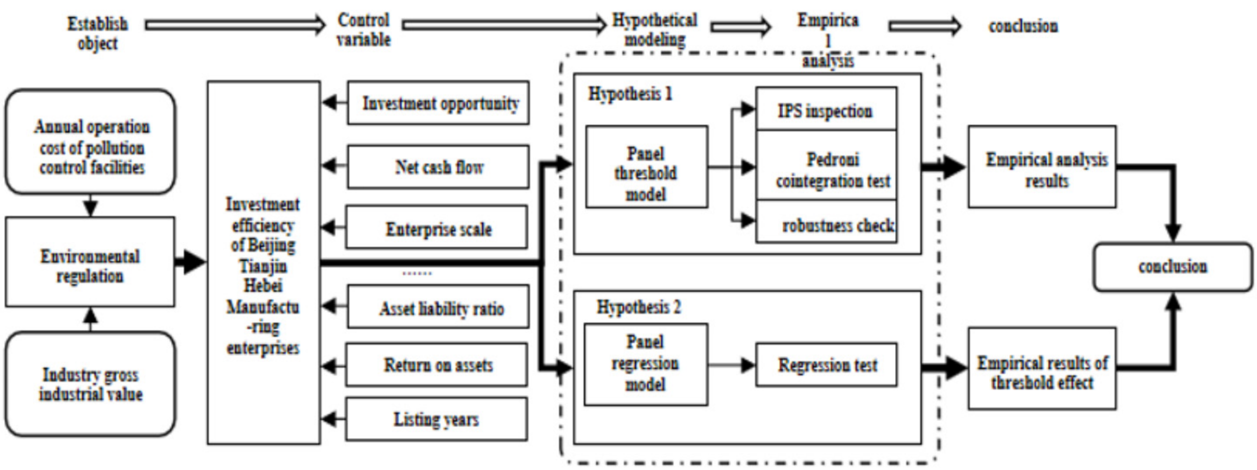

Figure 1. Research design. Dashed box indicates an empirical analysis of Hypotheses 1 and 2.

Firstly, the research data of manufacturing enterprises listed on the Shanghai and Shenzhen stock markets in the Beijing, Tianjin, and Hebei region from 2011 to 2017 are screened. Through the manual sorting of the China Environmental Statistics Yearbook and the China Industrial Statistics Yearbook, the ratio of the annual operation cost of pollution control facilities to the total industrial output value of the industry is obtained to measure the indicators of environmental regulation. The relevant financial indicators are selected from the CSMAR Guotai'an database, and the Richardson model is used to measure the investment efficiency indicators of manufacturing companies.

Secondly, by adding control variables such as investment opportunities, net cash/total output value, enterprise scale, and asset liability ratio, a panel regression model is constructed for the IPS (Im-Pesaran-Shin) test, Pedroni cointegration test, and model robustness test to analyze the impact of environmental regulation on enterprise investment efficiency.

Thirdly, the panel threshold model is constructed to test the number of thresholds and confirm the threshold value in order to verify the nonlinear threshold effect of environmental regulation on investment efficiency.

4.2. Sample Selection and Data Processing

This paper selects the manufacturing data of A-share enterprises listed on the Shanghai and Shenzhen stock markets in the Beijing–Tianjin–Hebei region from 2011 to 2017, for a total of 128 listed companies and 896 annual observations. The listed manufacturing companies were selected because the manufacturing industry is harmful to the environment and is greatly affected by environmental regulation. The financial data of enterprises were taken from the CSMAR Guotai'an database, and the data of environmental regulation and industry were taken from the China Environmental Statistics Yearbook and China Industrial Statistics Yearbook. As a result of the reclassification of manufacturing industries in 2012, the classification of industries has been manually organized. For the "total industrial output value" data of various industries, since the National Bureau of Statistics no longer discloses this index to the outside world as of 2012, this paper chooses the "industrial sales output value" of various industries to approximately replace "total industrial output value", and the numerical error of the two indexes is not more than 5% after comparative tests. Data processing and analysis were performed using Stata15.

4.3. Measurement of Environmental Regulation

At present, both domestic and overseas scholars have studied the measurement of environmental regulation indicators, mainly from the following angles: first, referring to the definition and connotation of environmental regulation, investigating environmental regulation policy from the level of its intensity; second, the annual operation cost of pollution control facilities is measured by the ratio of the total industrial output value of the industry, which mainly includes the operational cost of waste gas and wastewater treatment facilities; third, using the proportion of investment expenditure on pollution control compared with the total cost or total output value of enterprises to investigate their investment in pollution control; fourth, attention is paid to the emission of pollutants from enterprises, and environmental regulation indicators are expressed with the emission of pollutants such as waste gas, wastewater, and solid waste; fifth, the number of times the environmental regulation agencies inspect and supervise the sewage discharge of enterprises. To some extent, the above methods have shortcomings and defects, considering the completeness of index construction and the availability of data, as well as the inability to directly obtain the relevant environmental indicators of each company; this paper refers to the second method. Therefore, the index of environmental regulation intensity is defined as the sum of the operating costs of waste gas treatment facilities and wastewater treatment facilities divided by the total industrial output value of each industry. According to the standard of the manufacturing industry division disclosed by the China Environmental Statistics Yearbook, this paper divides the listed manufacturing companies in the Beijing–Tianjin–Hebei region into 21 industries and constructs the intensity variable industry environmental regulation:

$$EIntense_{i,t} = (Expwg_{i,t} + Expww_{i,t})/VS_{i,t} * 1000 \quad (1)$$

$EIntense_{i,t}$ refers to the intensity of environmental regulation in the year t of industry i, that is, the cost of pollutant treatment per thousand CNY of total industrial output value, abbreviated as $EIntense_{i,t}$. $Expwg_{i,t}$, and $Expww_{i,t}$, respectively, which indicate the annual operating cost of waste gas and wastewater treatment facilities in the year t of industry i. By adding the two costs and deflating the total industrial output value in the year t of industry i, the intensity of environmental regulation can be obtained.

4.4. Measurement of Investment Efficiency

There are many methods to measure and express the efficiency of enterprise investment in academic circles, but at present the Wurgler model, marginal $TobinQ$ model, and Richardson model are generally recognized. Richardson's model can directly measure the investment efficiency of manufacturing companies in a specific year, so this paper uses Richardson's model to measure the investment efficiency of manufacturing companies, that is, the investment efficiency is expressed by the sensitivity coefficient of investment expenditure $Invt_{i,t}$ to investment opportunities $TobinQ$; the higher the sensitivity coefficient, the higher the investment efficiency of an enterprise. Investment expenditure is equal to the ratio of total cash paid by enterprises for the purchase and construction of fixed assets, intangible assets, and other long-term assets to total assets (Liu and Liu, 2010). The measurement of investment opportunity is expressed by value, that is, the ratio of the stock market value to the total liabilities and total assets of listed companies in the securities market. The $TobinQ$ value of listed companies is positively related to the growth of enterprises, and the higher its value, the greater the opportunity for enterprises to increase investment. Based on the above facts, this paper chooses the $TobinQ$ value to represent the investment opportunities of enterprises, that is, (total stock market value + total liabilities)/total assets at the end of the period.

Therefore, this paper uses the sensitivity of the ratio of investment expenditure to investment opportunities to measure investment efficiency, which is also a widely used model in academia, and is given as follows:

$$Invt_{i,t} = \alpha_0 + \alpha_1 Tq_{i,t} + \alpha_2 CF_{i,t} + \alpha_3 Size_{i,t} + \alpha_4 Lev_{i,t-1} + \alpha_5 Seo_{i,t} + \alpha_6 Roa_{i,t} + \alpha_7 Age_{i,t} + \sum \mu Year_{i,t} + \sum \tau Industry_{i,t} \quad (2)$$

where $Invt_{i,t}$ expresses investment expenditure, which includes the expenditure of purchasing and constructing fixed assets, intangible assets and other long-term assets, enterprise M&A expenditure, and company R&D investment and advertising expenditure in a broad sense, taking into account the non-sustainability of M&A expenditure, company R&D, and advertising expenditure and their availability in financial statements. In this paper, the fixed assets, intangible assets, and other long-term assets of the company are used as investment expenditure. The value of $Invt_{i,t}$ is the ratio of total cash paid for the construction of fixed assets, intangible assets, and other long-term assets to total assets. $Tq_{i,t}$ represents the $TobinQ$ value of the enterprise, which is (total market value of the company's stock + net debt)/total assets. $CF_{i,t}$ represents the ratio of net cash flows from operating activities to total assets (Liu, 2018). $Size_{i,t}$ represents the size of the enterprise, expressed as the natural logarithm of the company's total assets. $Lev_{i,t-1}$ represents the asset-liability ratio of the enterprise, which is delayed for one period. $Seo_{i,t}$ represents the ratio of cash received by an enterprise from equity investments to total assets. $Roa_{i,t}$ represents the rate of return on the assets of an enterprise, expressed by the ratio of net profit to total assets of an enterprise, and $Age_{i,t}$ represents the listing life of an enterprise.

4.5. Control Variables

Taking into account that the investment efficiency of enterprises will be subject to the impact of various factors, in addition to the explanatory variables in the model should be added the control variables: $CF_{i,t}, Size_{i,t}, Lev_{i,t-1}, Seo_{i,t}, Roa_{i,t}, Age_{i,t}$. At the same time, 6 annual dummy variables and 20 industry dummy variables were added to control the influence of year and industry factors on the regression results.

4.6. Research Model Design

Based on the above theoretical analysis and research assumptions, this paper establishes the following panel regression model to empirically study the impact of environmental regulation on the investment efficiency of listed manufacturing companies in the Beijing–Tianjin–Hebei region:

$$\begin{aligned} Invt_{i,t} = \beta_0 + \beta_1 Tq_{i,t} + \beta_2 EI_{i,t} + \beta_3 Tq_{i,t} \times EI_{i,t} + \beta_4 CF_{i.t} + \beta_5 Size_{i,t} + \\ \beta_6 Lev_{i,t-1} + \beta_7 Seo_{i,t} + \beta_8 Roa_{i,t} + \beta_9 Age_{i,t} + \sum \mu Year_{i,t} + \sum \tau Industry_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where $Invt_{i,t}$ refers to the investment expenditure of the enterprise; β_0 is a constant item; $Tq_{i,t}$ is the $TobinQ$ value of the enterprise, which is the investment opportunity; and $EI_{i,t}$ is the intensity of the environmental regulation of the enterprise. Additionally, the coefficient β_3 of the interactive item $Tq_{i,t} \times EI_{i,t}$ expresses the impact of the intensity of environmental regulation on the efficiency of enterprise investment.

4.7. Establishment of Panel Threshold Model

In order to explore the non-linear threshold effect of environmental regulation on the investment efficiency of listed manufacturing companies in the Beijing–Tianjin–Hebei region, we verify Hypothesis 2. Hansen (1999) proposed the threshold model as shown below, which has strong representativeness and theoretical significance. This paper uses the principle of the model for reference and builds the threshold model based upon it. Hansen's basic equation is:

$$y_{i,t} = \mu_i + \beta_1 x_{i,t} I(q_{i,t} \le \gamma) + \beta_2 x_{i,t} I(q_{i,t} > \gamma) + e_{i,t} \quad (4)$$

In Hansen's equation, $I(\cdot)$ represents the index function; the value is 1 when the corresponding conditions are met; otherwise, the value is 0. $q_{i,t}$ is the threshold variable, γ is the threshold value, and $e_{i,t}$ is a random perturbation term, where i and t represent the industry and year, respectively.

$q_{i,t}$, as a threshold variable, divides the sample data into several different groups, and the regression coefficients of the model are different in different threshold intervals. The threshold model has the following two advantages: first, it does not need to establish nonlinear equations, and the model expression is more concise and intuitive; second, the number and value of the threshold are only determined by the endogeneity of the sample data.

The threshold regression model is established as follows:

$$Invt_{i,t} = \alpha_1 Tq_{i,t} EI_{i,t} I(EI_{i,t} < q_{i,t}) + \alpha_2 Tq_{i,t} EI_{i,t} I(EI_{i,t} > q_{i,t}) + Controls_{i,t} + \varepsilon_{i,t} \quad (5)$$

$I(\cdot)$ is the index function; the value is 1 when the condition is true and 0 when the condition is not true. The environmental regulation intensity $EI_{i,t}$ is the threshold variable, the interaction item $Tq_{i,t}EI_{i,t}$ is the main explanatory variable, and the enterprise investment expenditure $Invt_{i,t}$ is the explanatory variable. For the control variables $Controls_{i,t}$, $CF_{i,t}, Size_{i,t}, Lev_{i,t-1}, Seo_{i,t}, Roa_{i,t}, Age_{i,t}$ are included.

5. Model Testing

5.1. Data Stationery Test

In order to ensure the reliability of the selected sample data and the accuracy of the regression results, the sample data are tested for stationarity, that is, the unit root test is carried out for the selected variables. In this paper, the commonly used IPS (Im-Pesaran-Skin) test method is selected, and the results are shown in Table 1.

From the results of the unit root test in Table 1, we can see that the first-order differences of the main variables in the model are stable and reject the original hypothesis at the level of the 1% unit root test, that is, no unit root is found in the model. Hence, it is reasonable to assume that the variables in the model are one-order single-integral variables, so we can deal with the model in the next step.

Table 1. IPS unit root test results for primary variables.

Variables	t-Bar	W[t-Bar]	*p*-Value	Stationarity
$Invt_{i,t}$	−3.296	−18.257	0.000	Y
$EI_{i,t}$	−2.324	−8.445	0.000	Y
$Tq_{i,t}$	−1.896	−4.122	0.000	Y
$Lev_{i,t-1}$	−1.739	−2.535	0.006	Y
$Roa_{i,t}$	−1.993	−5.103	0.000	Y
$CF_{i.t}$	−2.191	−7.1	0.000	Y
$Seo_{i,t}$	−2.781	−13.058	0.000	Y
$Size_{i,t}$	−1.535	−0.479	0.006	Y

5.2. Cointegration Test

The purpose of the cointegration test is to further test whether there is a long-term stable equilibrium relationship between variables, to avoid false regression in the model and to ensure the scientificity and accuracy of the experimental results. The Pedroni cointegration test is used in this paper, and the results are shown in Table 2.

Table 2. Pedroni cointegration test results.

	Statistic	*p*-Value
Modified Phillips–Perron test	26.8105	0.0000
Phillips–Perron test	−9.6828	0.0000
Augmented Dickey–Fuller test	22.7401	0.0000

As can be seen from Table 2, the ADF statistic of the Pedroni test rejects the original hypothesis at the 1% level, indicating that all variables in the model have a significant long-term cointegration relationship, so the data can be analyzed by building a panel regression model.

5.3. Panel Regression Results

In order to test Hypothesis 1, we analyze the effect of environmental regulation on the investment efficiency of listed manufacturing companies in the Beijing–Tianjin–Hebei region and perform panel regression on the sample variables. The regression results are shown in Table 3.

Table 3. Regression results.

$Invt_{i,t}$	Coef.	Std. Err.	t	*p*-Value
$Tq_{i,t}$	0.0033783 ***	0.0011367	2.97	0.003
$EI_{i,t}$	0.0063069	0.0055841	1.13	0.259
$Tq_{i,t} \times EI_{i,t}$	−0.0038093 ***	0.0013031	−2.92	0.004
$CF_{i.t}$	−0.0371227 *	0.0212962	−1.74	0.082
$Lev_{i,t-1}$	−0.0124431	0.0127347	−0.98	0.329
$Size_{i,t}$	−0.0001564	0.003236	−0.05	0.961
$Seo_{i,t}$	−0.0026413	0.123079	−0.21	0.830
$Roa_{i,t}$	0.0412172 *	0.0240414	1.71	0.087
$Age_{i,t}$	0.0938498	0.0882991	1.06	0.288
R-sq		0.2242		
F-test		14.51 ***		

Note: * and *** denote significance at 10% and 1% levels, respectively, and coefficients without a marker mean not significant in regression.

As Table 3 shows, the regression coefficient of investment opportunity $Tq_{i,t}$ is 0.0034, which is significantly positive at the level of 1%. The regression coefficient of the interaction $Tq_{i,t} \times EI_{i,t}$ between investment opportunity and environmental regulation intensity is

−0.0038, which is significantly negative at the level of 1%. Therefore, the empirical results verify the validity of Hypothesis 1.

For the control variables, the regression coefficient of net cash flow $CF_{i.t}$ from operating activities is −0.0371, which indicates that for the manufacturing companies in the Beijing–Tianjin–Hebei region, the financing behavior of enterprises inhibits investment behavior, and the inducing factor may be that the internal management system of enterprises is relatively strict, or that they have a stronger financing tendency. The regression coefficient of return on assets $Roa_{i,t}$ is 0.4122, and at the level of 10%, it shows that the higher the rate of return on assets of enterprises, the more it can trigger the investment behavior of enterprises and play a significant role in investment support. In addition, the regression coefficient of the asset-liability ratio, company size, equity refinancing amount, and listing period is not significant, and it is speculated that there is a weak relationship with the investment expenditure behavior of enterprises.

5.4. Model Robustness Test

In order to further test the reliability of the model method and index interpretation ability and verify whether the regression results will change with the change in parameter settings, a robustness test of the model is carried out in this paper. Starting from the variables, this paper uses the total sales of the company instead of the total assets of the company to express the company size of listed companies and then performs regression; the results are shown in Table 4 below. By comparison, the regression results are basically consistent with the previous research conclusions, which show that environmental regulation has a significant negative impact on the investment efficiency of Beijing–Tianjin–Hebei manufacturing enterprises as a whole.

Table 4. Regression results.

$Invt_{i,t}$	Coef.	Std. Err.	t	*p*-Value
$Tq_{i,t}$	0.0030931 ***	0.0015462	2.37	0.004
$EI_{i,t}$	0.0045164	0.0046324	1.34	0.221
$Tq_{i,t} \times EI_{i,t}$	−0.0029864 ***	0.0019643	−2.78	0.002
$CF_{i.t}$	−0.0562468 *	0.0362462	−1.64	0.081
$Lev_{i,t-1}$	−0.0236537	0.0174253	−0.87	0.313
$Size_{i,t}$	−0.0001534	0.002783	−0.05	0.932
$Seo_{i,t}$	−0.0029532	0.174263	−0.26	0.821
$Roa_{i,t}$	0.0535143 *	0.0362542	1.85	0.086
$Age_{i,t}$	0.0685438	0.0964253	1.21	0.254
R-sq		0.2554		
F-test		12.35 ***		

Note: * and *** denote significance at 10% and 1% levels, respectively, and coefficients without a marker mean not significant in regression.

6. Analysis of Threshold Effect

The panel threshold model requires that panel data must be stable in order to avoid pseudo-regression problems, so the first step is to test the unit root of the data. Since the panel regression model has been established in the previous unit root test of variables, and the main variables are stable under the first-order difference, we directly carry out panel threshold regression here.

The panel threshold estimation needs to solve the following two problems: the first is to determine the threshold number and threshold value; the second is to estimate the regression coefficients of different threshold intervals and to test the estimated values. First, the model is tested for the number of thresholds, and the Stata software is used to test the significance of threshold variables when there is a single threshold, a double threshold, or three thresholds; the test results are shown in Table 5.

Table 5. Results of significance test for panel threshold estimation.

Threshold Number	F-Value	p Value	Threshold Value	10%	5%	1%
Single	17.47 **	0.0333	2.2358	13.18 64	16.1936	21.1981
Double	5.00	0.5800	2.2358 0.4336	13.70 38	18.165 51	24.4599
Triply	5.88	0.4100	2.2358 0.4703 0.4336	12.2595	14.81/43	19.68/78

Note: The F value and related critical values in the table are the results of 300 repeated samples by using the "bootstrapping method". ** denote significance at 5% levels, and coefficients without a marker mean not significant in regression.

As can be seen from Table 5, the single threshold test rejects the original hypothesis at the significance level of 1%, that is, it rejects the hypothesis that the original model has no threshold, indicating that there is a threshold in the model. In the test using a double threshold and three thresholds, the significance level is 0.58 and 0.41, respectively, which should accept the original hypothesis of the model and prove that there is only a single threshold in the model (Peng et al., 2018). Thus, it can be determined that there is a single threshold of 2.2358 when the intensity of environmental regulation is used as a threshold variable.

After determining the threshold value and passing the significance test, the panel threshold estimation method is used to estimate the parameters of the main variables in the model. The estimation results of the relevant parameters are shown in Table 6.

Table 6. Panel threshold parameter estimation results.

$Invt_{i,t}$	Coef.	t-Value	p-Value
$Tq_{i,t} \times EI_{i,t}(EI_{i,t} < 2.2358)$	0.0018156 *	1.36	0.092
$Tq_{i,t} \times EI_{i,t}(EI_{i,t} \geq 2.2358)$	−0.0050565 ***	−4.24	0.000
$CF_{i,t}$	−0.039362 *	−1.87	0.061
$Lev_{i,t-1}$	−0.0137783	−1.09	0.276
$Size_{i,t}$	−0.0015878	−0.51	0.613
$Seo_{i,t}$	−0.007169	−0.59	0.555
$Roa_{i,t}$	0.0486278 **	2.07	0.039
$Age_{i,t}$	−0.006699 ***	−9.17	0.000
$Cons$	0.161001 **	2.46	0.014
R-sq		0.2240	
F-Value		27.43 ***	

Note: *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively, and coefficients without a marker mean not significant in regression.

From the estimated results in Table 6, we can see that when the intensity of environmental regulation is at a low level, below the threshold of 2.2358, the impact of environmental regulation intensity on the investment efficiency of listed manufacturing enterprises in the Beijing–Tianjin–Hebei region is positive, but its promotion effect is significant at the significant level of 10%. When the intensity of environmental regulation is gradually strengthened, greater than the threshold value of 2.2358, it will have a negative impact on the investment efficiency of enterprises, and this inhibitory effect shows a strong significance at the level of 1%. Hypothesis 2 is thus verified.

Table 7 shows the distribution of the environmental regulation intensity of the manufacturing industry in the Beijing–Tianjin–Hebei region from 2011 to 2017.

Table 7. Panel threshold and data distribution of Beijing–Tianjin–Hebei manufacturing industry.

Threshold and Interval	Industry
$EI_{i,t} < 2.2358$	Agricultural and sideline products processing industry, food manufacturing industry, wine, beverage and refined tea manufacturing industry, textile industry, textile clothing, clothing industry, leather, fur and feather products and footwear, printing and recording media reproduction, rubber and plastic products, metal products, general equipment manufacturing, special equipment manufacturing, transportation equipment manufacturing, electrical machinery and equipment manufacturing, computer, communications and other electronic equipment manufacturing, instrumentation manufacturing
$EI_{i,t} \geq 2.2358$	Petroleum processing, coking and nuclear fuel processing, chemical raw materials and chemical products manufacturing, pharmaceutical manufacturing, non-metallic mineral products industry, ferrous metal smelting and calendering industry, non-ferrous metal smelting and calendering industry

Among the 21 manufacturing industries in the Beijing–Tianjin–Hebei region, there are six industries whose environmental regulation intensity is higher than the threshold of 2.2358, namely the petroleum processing, coking and nuclear fuel processing industry, the chemical raw materials and chemical products manufacturing industry, the pharmaceutical manufacturing industry, the non-metallic mineral products industry, the ferrous metal smelting and calendering industry, and the non-ferrous metal smelting and calendaring industry. The differing nature of these industries means that the environmental regulation intensity is not the same. When faced with the strengthening of environmental regulation, the response measures taken by enterprises in various industries are not the same, and therefore the impact on investment efficiency and effect is also different.

7. Discussion

With the increasingly strict background of China's environmental regulation and the increasingly significant trend of the impact of environmental policies on the development of enterprises, based on environmental regulation policy produced by the externality theory, this study takes the listed manufacturing enterprises in the Beijing–Tianjin–Hebei region as the research sample to discuss the economic impact of environmental regulation on the manufacturing enterprises in this region and its impact mechanism.

For the first research question of this paper, the difference between this paper and some analyzed literature is that they have studied the impact of environmental regulation on enterprises from many other aspects. For example, Sharma (2000) [16] focuses the impact of environmental regulation on the strategic planning of enterprises and some analyzed literature focus more on the impact of environmental regulation on the quantity of enterprise investment (Zhang, J., 2016 [26]; Yuan, Y.J. and Xie, R.H., 2016; Zhou, H.N., 2019 [34]) or the overall production efficiency of enterprises (Isabelle Piot–Lepetit, 2007 [18]; Chintrakam, 2008), while this paper focuses on the impact of environmental regulation on the investment quality, i.e., investment efficiency. For the verification of "Porter Hypothesis", some analyzed literature focused more on the positive impact of enterprise innovation caused by environmental regulation on enterprise research and development, governance cost, productivity, and technological development (Jaffe and Palmer, 1997 [29];

Brunnermeier and Cohen, 2003 [30]; Hamamoto, 2006 [31]; Ramanathan, R. et al., 2017 [22]; Garcia-Quevedo, 2021 [24]; Yang, Y.L., 2020 [33]). Other analyzed researchers also believe that environmental regulation improves the private investment efficiency of enterprises and reduces the investment opportunities of enterprises (Yao Du et al., 2018 [27]; Z. Feng et al., 2018 [28]), that appropriate environmental management and investment strategies enable enterprises to reduce costs and risks so as to improve energy efficiency and achieve sustainable development (Song, H.X., 2016 [23]; Xiong, F.P. and Bo, W.A. et al., 2019), and that only when enterprises overinvest can environmental regulation policies improve enterprise investment efficiency (Li, T., 2021 [36]). However, some analyzed literature included the use of the data of their country to conclude that there is no obvious relationship between environmental regulation and enterprise performance (Stoeve, J., 2018 [20]) and that environmental regulation policies have an inhibitory effect on enterprise investment efficiency (Paulsson, 2004 [17]; Zhou, H.N., 2019 [34]; Wang, X.H., 2020 [35]). Therefore, at present, scholars have yet to reach a consensus on the impact of environmental regulation on enterprise investment efficiency. In this paper, through the analysis of the industrial characteristics of manufacturing enterprises and the characteristics of environmental regulation policies in the Beijing–Tianjin–Hebei region, the Hypothesis 1 is put forward that environmental regulation does not significantly promote the investment efficiency of enterprises in the Beijing–Tianjin–Hebei region. The research results show that the impact of environmental regulation intensity on enterprise investment efficiency is negative, which responds to the first research question proposed in this paper and is also the same as some experts' research views on the inhibitory effect of environmental regulation policies on enterprise investment efficiency, which reflects the fact that manufacturing in the Beijing–Tianjin–Hebei region is mainly the traditional resource- and labor-intensive manufacturing industry and its technological innovation ability is not strong on the whole. The contribution is to take a national key development area as the research scope to explore the impact of environmental regulation on investment efficiency and explain that due to the existence of inducing factors of environmental regulation, manufacturing enterprises face more stringent internal and external management systems and stronger financing constraints limiting the occurrence of investment behavior. From the perspective of empirical analysis, this paper extends the research on the relationship between environmental regulation and manufacturing investment efficiency, and the research results have reference value for regional coordinated development.

For the second research question of this paper, the impact mechanism of environmental regulation on investment efficiency in the Beijing–Tianjin–Hebei region, some analyzed literature have found that different environmental policies and measures have a threshold effect on technological innovation (Shen, N., 2012 [37]) and in promoting the upgrading of industrial structure (Song, W.X., Han, W.H., 2021 [42]). Due to the regional gap, time gap and industrial gap in the economic effects of environmental regulation, it is difficult to determine the size of "compliance cost" and "innovation compensation" and the economic effects of environmental regulation are nonlinear (Conrad and Wastl, 1995 [39]; Lanoie et al., 2008 [40]). Some other analyzed literature focus on the impact of environmental regulation on enterprise innovation, which showed that when the intensity of environmental regulation exceeds a specific "threshold", the existence of environmental regulation will bring opportunities for innovative production (Su, H., 2018 [38]; Pang, M.C. and Ning F.X., 2022 [41]). Based on them, the Hypothesis 2 is put forward that there is a nonlinear threshold effect in the impact of environmental regulation intensity on enterprise investment efficiency. Different from the analyzed literature, this paper answers the problem of the impact mechanism of regional environmental regulation on investment efficiency in a coordinated development region. Similar to the analyzed literature, the existence of threshold effect is verified. The panel threshold model is constructed to verify the existence of threshold effect in this paper. The results of this study clearly show that when the intensity of environmental regulation exceeds the threshold value of 2.2358, it has a significant negative impact on the investment efficiency of enterprises, which shows that environmental regulation tends to make the internal management system of enterprises more strictly. Once it exceeds a certain critical point, it will inhibit investment behavior. The contribution of this study is that in the face of more and more strict environmental regulation in regions with rapid collaborative development, such as the environmental regulation policy in the Beijing–Tianjin–Hebei region, when making policy in the face of manufacturing industry, we need to consider the threshold and make targeted adjustment to achieve a win-win situation of environmental protection and investment growth. The research conclusion has certain practical value for the coordinated development region to coordinate the unbalanced relationship between environment and economy and realize the healthy and benign development of both on the basis of reasonable responses to environmental regulation and improving pollution prevention and control.

8. Conclusions

8.1. Summary

Environmental pollution and the depletion of resources has become a common concern of governments and society today. How to take into account environmental health and economic health and achieve sustainable development that can promote economic development without damaging the environment has become a topic of concern. Therefore, this paper focuses on the mechanisms of influence of environmental regulation on the investment efficiency of enterprises in the Beijing–Tianjin–Hebei region, selecting the data of listed manufacturing enterprises in the Beijing–Tianjin–Hebei region from 2011 to 2017 as the research sample, using a panel regression model and panel threshold model to test the impact of environmental regulation on enterprise investment efficiency in order to provide a theoretical basis for constructive suggestions for the government of Beijing, Tianjin, and Hebei, formulate environmental policies, and compensate for the lack of relevant research in the field of enterprise investment efficiency.

8.2. Key Findings

(1) The whole impact of environmental regulation on investment efficiency is negative. Environmental regulation can affect the sensitivity of investment expenditure to investment opportunities by affecting investment opportunities and investment expenditure, that is, investment efficiency. But because there are simultaneous positive and negative effects: environmental regulation may reduce investment efficiency by causing over-investment or underinvestment and may also promote the innovation and transformation of enterprises in order to improve investment efficiency, so the negative impact is not significant.

(2) The intensity of environmental regulation has a "threshold effect"; that is, there is a threshold value of environmental regulation, which tends to improve the impact on enterprise investment efficiency, but this role is not significant. When the intensity of environmental regulation is higher than the threshold value of 2.2358, environmental regulation has a significant inhibitory effect on the investment efficiency of enterprises.

The conclusion of this paper has certain significance for the government in the formulation of environmental regulation policy: blindly strengthening or weakening the intensity of environmental regulation cannot effectively promote the investment efficiency of enterprises, and it should instead be based on the actual situation of different manufacturing industries in the scope of the environmental regulation level. Reasonable and effective environmental regulation policies with heterogeneity and pertinence need to be set.

8.3. Policy Implications

(1) When the environmental regulation level of the industry is low, these industries are generally lightly polluting industries. The characteristics of knowledge- and technology-intensive industries mean that their resource dependence is weak, their energy consumption is small, and their ability to pollute the environment is weak; at the same time, it also demonstrates that these industries are less lazy with regards to resources and have strong

innovation ability. It is easier to achieve the fungibility of resources through technological transformation and industrial upgrading. Therefore, the government can properly improve the level of environmental regulation of these lightly polluting industries, stimulate these enterprises to carry out green technology innovation, and achieve management system reform within the reasonable scope of environmental regulation, so as to improve the investment efficiency of enterprises, and realize pollution control, emission reduction, and environmental protection at the same time.

A specific point of breakthrough for the government to improve environmental regulation can be to actively promote the innovation of environmental regulation tools, change the original compulsory and inefficient policy tools, move from command-control environmental regulation to incentive environmental regulation, give enterprises a wider choice and operational flexibility, and achieve energy saving and emission reduction goals more efficiently and at lower cost. The government should vigorously promote the application of new environmental protection mechanisms and find new engine points to encourage enterprises to attach importance to environmental protection and pollution control, such as signing voluntary emission reduction agreements, the autonomous treatment of wastewater and waste gas, etc. By stimulating companies to upgrade their green production technology, upgrade their sewage control equipment, and improve their internal management systems, enterprises can voluntarily reduce pollution. At the same time, they can improve their own production capacity and investment efficiency and reduce production costs. Thus, we will achieve a win–win situation with regards to environmental protection and efficient investment.

(2) For heavily polluting industries, on the basis of maintaining the existing level of environmental regulation, the government should focus on the re-optimization, combination, and upgrading of heavily polluting industries and simultaneously integrate production resources and reset production factors. Additionally, for those enterprises with strong innovation ability and good environmental benefit, production resources should be allocated to them in order to guide the promotion of a green production mode for enterprises in the industry.

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