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Research on the economic impact of environmental regulation: Literature review

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Abstract: *The parallel of economic growth and green development is the long-term social development goal of China. As an important means to realize the green transformation of social and economic development, environmental regulation has always been highly concerned by the government and academia. From the perspective of the economic effects of environmental regulation, this paper combs the literature on the impact of environmental regulation on the development of green economy in China in recent years from the perspective of macroeconomic factors, and summarizes and comments on the existing research. On this basis, relevant suggestions are put forward, which provides a feasible direction for future research on the economic impact of environmental regulation.*

Keywords: *environmental regulation; green innovation; economic effects*

1. Introduction

As the largest developing country in the world, China's extensive industrial development model formed in the early years has greatly improved the speed of economic growth, but it has also caused environmental development problems that cannot be ignored. In recent years, China has introduced a series of measures to coordinate economic development and environmental protection. Environmental regulation refers to the general rules or special behaviors formulated and implemented by administrative agencies that directly interfere with market allocation or indirectly change the supply and demand decisions of enterprises and consumers[1]. In order to achieve a win-win situation between economic development and environmental protection, it is necessary to use environmental regulation tools reasonably.

The means of environmental regulation can be roughly divided into three types: command control, market incentive and public voluntary. China's early environmental regulation was dominated by command control, mainly through laws and regulations, administrative means and other means to regulate the behavior of polluting enterprises, to achieve the purpose of controlling pollution emissions. Under China's current administrative system, command-and-control environmental regulation is easy to decentralize its objectives through step-by-step decomposition[2] and the time lag of policy impact is short, which can have a greater impact on the production and operation activities of enterprises in the short term[3]. However, with the development of market economy and the complexity of social environment, command-and-control environmental regulation has problems such as too large implementation cost and inability to provide long-term dynamic supervision[4]. Single command-and-control environmental regulation has been unable to meet the needs of further development of market economy. In recent years, China has paid more attention to the use of market-incentive environmental regulation tools. The government indirectly affects enterprises by regulating the macro environment of the market, so as to achieve the purpose of reducing pollution emissions by enterprises. Compared with command-controlled environmental regulation tools, market-motivated environmental regulation tools are often more flexible, and enterprises have more autonomy. They can adjust their own production and R&D according to the market background and the actual situation of enterprises, reduce pollution emissions, and carry out green technology upgrading and transformation[5]. In addition, with the increasing emphasis on environmental issues from all walks of life and the reduction of the cost of public information acquisition, the public's willingness to voluntarily govern the environment has been further enhanced. The public will spontaneously supervise polluting enterprises, and promote social public opinion to pressure polluting enterprises and safeguard public interests through reporting petitions and media exposure. Public voluntary environmental regulation can have a positive impact on environmental governance from two channels. First, the

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improvement of public environmental attention can inhibit the collusion behavior of local governments and enterprises, and promote local governments to improve the intensity of environmental regulation. Second, the increase in public environmental attention will gradually increase the demand for green products by consumers in the market, forcing enterprises to carry out green technology innovation, and ultimately bring about the improvement of environmental quality[6]. It should be recognized that compared with other developed countries, China's public voluntary environmental regulation is still in its infancy[4].

In recent years, the research on the economic effects of environmental regulation has been carried out mainly through micro and macro aspects. At the macro level, it mainly studies the impact of environmental regulation on macro factors such as economic growth and employment income. Moreover, most of the early studies did not distinguish the types of environmental regulations, and more scholars used indicators such as pollution emission intensity or the proportion of environmental pollution control investment in GDP to measure the intensity of environmental regulation[7]. In recent years, with the rise of measurement methods such as double difference model and triple difference model, scholars tend to subdivide environmental regulation into command control type, market incentive type and public voluntary type, and explore the different effects of different environmental regulation tools on micro and macro, long-term and short-term, as well as the corresponding mechanism of action. This paper reviews the research on environmental regulation and economic development in recent years, explores the economic effects of environmental regulation at the macro and micro levels, and provides literature support for further selecting more reasonable environmental regulation tools, formulating reasonable environmental policies, and promoting the green transformation of economic development.

2. The impact of environmental regulation on enterprises at the micro level.

2.1. Environmental regulation inhibits the development of enterprise production

You Daming and Jiang Ruichen[8] used the batch of environmental petition petitions in various regions to measure public participation environmental regulation, and found that public participation environmental regulation had a crowding-out effect on corporate technological innovation. Tu Zhengge et al.[9]examined the impact of the reform of industrial sulfur dioxide emission fee collection standards on corporate performance, and found that at the enterprise level, the adjustment of emission fee standards cannot force enterprises to carry out technological innovation, but may reduce the performance of listed industrial enterprises by inhibiting their investment activities. Tao Feng et al.[10]investigated the impact of environmental protection target responsibility system on the quantity and quality of corporate green innovation, and found that command-and-control environmental regulation has promoted the increase in the number of corporate green technology patent applications, but it has also brought about a decline in quality. Taking the provincial panel data of China's industry from 2008 to 2018 as a sample, Zhang Wenqing and Chen Yuke[11] empirically tested the direct impact of environmental regulation tools on green technology innovation by using the hierarchical regression analysis method, and found that command-and-control environmental regulation has a significant negative correlation with enterprise green technology innovation.

2.2. Environmental regulation promotes the development of enterprise production

Wang Banban and Qi Shaozhou[12] found that both command-controlled environmental regulation and market-motivated environmental regulation are helpful to induce technological innovation of enterprises, but command-controlled environmental regulation has a more obvious effect in industries with high degree of nationalization. Ye Qin et al.[13] explored the impact of different environmental regulation tools on China's energy conservation and emission reduction technology innovation from the perspective of time series evolution characteristics, and found that compared with the base period, both command-based environmental regulation and market-based environmental regulation have a significant positive impact on technological innovation lagging one period. Fan Ziying and Zhao Renjie[14] evaluated the impact of environmental justice strengthening on environmental pollution control by taking the establishment of environmental courts as a quasi-natural experiment. It was found that the existence of environmental courts significantly reduced the discharge levels of industrial wastewater and industry in the experimental area. Ren Shenggang[15], Qi Shaozhou[16], Liu Jinke and Xiao Yiyang[17] studied the market incentive environmental regulation of different measures, and found that market incentive environmental regulation can effectively promote the green innovation activities

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of enterprises in polluting industries, and non-state-owned enterprises have a stronger response than state-owned enterprises. Wang Mingyue et al.[18]found that although market-motivated environmental regulation will have an inhibitory effect on the end-of-pipe green technology innovation of enterprises, on the whole, market-motivated environmental regulation has a significant role in promoting the green technology innovation of industrial enterprises.

2.3. There is a nonlinear relationship between environmental regulation and enterprise production development

Some scholars believe that the relationship between environmental regulation and enterprise green technology innovation is not just a simple linear relationship, but a nonlinear relationship that changes with different development time, such as threshold phenomenon and inflection point phenomenon. Guo Jin[19] conducted a threshold effect test on environmental regulation and green technology innovation, and found that with the increase of environmental regulation intensity, command-and-control and market-incentive environmental regulations have a non-linear effect on green technology innovation from weak to strong. Zhang Juan et al.[20], Wang Zhenyu et al.[21]found that the impact of environmental regulation on the output of green technology innovation presents a U-shaped relationship. With the increase of regulatory intensity, the output of green technology innovation decreases first, and after reaching the minimum value, it will increase with the increase of regulatory intensity. Kang Zhiyong et al.[22]found that the intensity of market incentive and public participation environmental regulation and the development of technological innovation of enterprises are inverted 'U' type, while the intensity of command control market regulation on the development of technological innovation of enterprises is 'U' type. Based on the dynamic panel smooth transition model and the mediating effect model, Fan Dan and Sun Xiaoting[23] discussed the nonlinear effects of dual environmental regulation on green technology innovation and green economy, and found that the market incentive environmental regulation showed the characteristics of linear to nonlinear transformation when it exceeded the threshold. Compared with the command-and-control environmental regulation, the market incentive environmental regulation showed the characteristics of linear to nonlinear transformation.

3. The economic effects of environmental regulation at the macro level

From a macro perspective, more scholars tend to study the impact of environmental regulation on macroeconomic factors such as economic development efficiency or economic development quality. The selection indicators generally include two categories. One is to use economic growth efficiency indicators represented by total factor productivity to measure, such as green technology innovation efficiency[24], industrial total factor energy efficiency[25]; secondly, the comprehensive evaluation index of economic development is constructed from multiple dimensions to measure the quality of economic development, such as Shi Huaping and Yi Minli[26]. The comprehensive evaluation index system of high-quality development is constructed from seven dimensions, such as economy, innovation and people's livelihood. The entropy method weight assignment is used to calculate the comprehensive evaluation index of China's inter-provincial high-quality development. Generally speaking, there are the following viewpoints in the academic circle: environmental regulation will inhibit the development of macroeconomic factors; environmental regulation will promote the development of macroeconomic factors; there is a nonlinear relationship between environmental regulation and the development of macroeconomic factors. In addition, because environmental regulation is specifically formulated and implemented by local governments, and the government will be affected by local economic development goals and past experience in other regions when considering environmental regulation tools, it is necessary to discuss the impact of regional environmental regulation on corporate decision-making behavior and the spillover effect of environmental regulation on neighboring regions, which has also received extensive attention in the academic community. Many scholars also pay attention to the impact of environmental regulation on the overall industrial development of the region and neighboring regions from this perspective.

3.1. Environmental regulation inhibits the development of macroeconomic factors

Xiao Quan and Zhao Lu[27] found that different types of environmental regulation have significantly different effects on FDI, but at this stage, both command-controlled environmental regulation and market-motivated environmental regulation have shown inhibitory effects on FDI. Liu Manfeng and Zhu Wenyan[28] analyzed the impact of three types of environmental regulation on technological

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innovation by constructing a system GMM model, and found that market-motivated environmental regulation will inhibit the development of technological innovation. Starting from the impact of environmental regulation on foreign direct investment, Song Wenyan and Han Weihui[29] found that both foreign direct investment and environmental regulation can significantly promote the upgrading of industrial institutions, but at the same time, excessive environmental regulation will weaken the promotion effect of foreign direct investment on the upgrading of industrial structure. Based on the panel data of 38 industrial sectors in China from 2004 to 2015, Wang et al.[30] estimated the net effect and influence of environmental regulation policies on environmental technology innovation in China's heavily polluting industries, and found that the implementation of environmental regulation policies could not significantly promote the improvement of green technology innovation in heavily polluting industries.

3.2. Environmental regulation promotes the development of macroeconomic factors

Sun Yuyang et al.[31] used the system GMM estimation method to analyze the impact of different types of environmental regulations and the overall comprehensive index of environmental regulations on the quality of economic growth. It was found that command-and-control environmental regulations promoted the improvement of economic quality, market-incentive environmental regulations inhibited the improvement of economic growth quality, and public participation environmental regulations did not have an impact on the quality of economic growth for the time being, but overall environmental regulations still played a role in promoting economic quality growth. Through the air pollution data of 288 prefecture-level cities in China, Wang Ling et al.[32] empirically tested that the environmental protection supervision system can significantly improve the control effect of air pollution. Ding et al.[33] examined the changes in carbon emission intensity of 282 prefecture-level and above cities in China from 2003 to 2017, and found that environmental regulation can significantly reduce the carbon emission intensity of cities. Based on the panel data of 278 prefecture-level cities in China from 2007 to 2016, Shangguan Xuming and Ge Binhua[34] examined the impact of technological innovation and environmental regulation on the quality of economic development, and found that environmental regulation has a significant direct promotion effect on the quality of economic development, and environmental regulation can strengthen the promotion effect of technological innovation on high-quality economic development.

3.3. There is a nonlinear relationship between environmental regulation and the development of macroeconomic factors

Li Ying et al.[35] measured the industrial total factor energy efficiency in various regions of China, and empirically tested the relationship between environmental regulation and industrial total factor energy efficiency. It was found that there was a 'U' type relationship between the two. When the intensity of environmental regulation crossed the inflection point, it could promote the improvement of industrial total factor energy efficiency. Tao Jing and Hu Xueping[7] constructed China's economic growth quality index from four dimensions, and found that there was an inverted 'U'-shaped dynamic relationship between command-and-control environmental regulation and China's economic growth quality. Yang et al.[36] used differential GMM estimation and other measurement methods to study the relationship between green innovation, environmental regulation and high-quality industrial development, and found that environmental regulation has a single threshold effect: when environmental regulation is lower than the threshold threshold, green innovation has a significant hindering effect on high-quality industrial development. On the contrary, green innovation can significantly promote high-quality industrial development. Fan Qingquan et al.[37] studied the impact of industrial structure upgrading on labor productivity under environmental regulation, and found that the growth rate of labor productivity would decline in the first stage of environmental regulation. When environmental regulation enters the second stage, the impact of environmental regulation on labor productivity is not significant.Wu Yunliang et al.[38] measured the relationship between environmental regulation, green technology innovation and high-quality development in 41 cities in the Yangtze River Delta, and found that environmental regulation had an inverted 'U'-type nonlinear effect on the high-quality economic development of cities in the Yangtze River Delta.

3.4. The impact of regional environmental regulation on corporate decision-making behavior

In addition to studying the impact of environmental regulation on green technology innovation and economic development from the macro and micro levels, a considerable number of scholars are based

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on the perspective of local government competition and pay attention to the impact of local government environmental regulation on corporate decision-making behavior from the perspective of geographical space. Some scholars have pointed out that for polluting enterprises, in-situ innovation and cross-regional transfer have a substitution effect on reducing the cost of environmental governance[39]. When the cost of green technology innovation is greater than the cost of cross-regional transfer, enterprises will choose to migrate to areas with looser environmental regulations rather than carry out technological innovation locally, thus affecting the level of economic development and technological innovation in local and neighboring areas. From the perspective of Chinese local governments, there is a yardstick competition between Chinese local governments. That is, due to information asymmetry, the central government often chooses some explicit yardsticks to measure local governments, and the most important indicator is economic growth performance[40]. In this context, environmental regulation has essentially become a means for local governments to compete. Local governments are not isolated when formulating environmental regulations. There will be a 'strategic' interaction between local governments[41], that is, when formulating environmental regulations, local governments will not only consider the actual situation of the region, but also refer to the relevant experience of geographically adjacent areas or areas with similar economic development. In order to compete for liquidity factors and solidify local resources, local governments will compete to reduce the intensity of local environmental regulation, forming a race to the bottom. Similarly, in order to strengthen regional advantageous resources and attract high-quality liquidity factors, local governments may also compete to improve the level of regional environmental regulation and form competitive environmental regulation.

In this regard, the spatial spillover effect of environmental regulation is discussed more, and scholars mostly use spatial econometric models and other methods to conduct empirical tests. Existing research has done a lot of discussions, but has not formed a consensus. It is worth noting that most empirical results believe that environmental regulation has a negative spatial spillover effect on neighboring areas. Shen Kunrong et al.[42], based on the spatial self-lag model, used instrumental variable regression to identify the causal relationship between environmental regulation and local pollution emissions in neighboring cities. The study found that environmental regulation will lead to the transfer of pollution. Dong and Wang[43] examined the local-neighbor green technology innovation effect of environmental regulation and its transmission mechanism, and found that environmental regulation will induce the transfer of polluting industries to neighboring areas. In the short term, the increase in the income level of neighboring areas will promote the improvement of green technology innovation, while in the long run, the development of green technology innovation will be inhibited. Liu Yufeng and Gao Liangmou[44] used the spatial Dubin model to analyze the spatial impact of environmental regulation and local protection on the upgrading of industrial structure, and found that command-controlled environmental regulation can promote the rationalization of local industrial institutions and has a significant negative spillover effect on neighboring areas.

4. Conclusions

By reviewing the relevant theories and relevant literature in recent years, it can be found that the academic community has achieved fruitful research results in the study of environmental regulation in recent years. It is not difficult to find that the current research on the economic impact of environmental regulation has the following characteristics:

(1) Most of the early studies are limited by the selection of data sources and measurement methods, and it is difficult to subdivide the types of environmental regulation. However, it is undoubtedly difficult to clearly identify the mechanism of environmental regulation by confusing different types of environmental regulation without distinction. The existing research is more and more inclined to discuss the impact of heterogeneous environmental regulation tools. In the relevant research, it also pays more attention to the heterogeneous impact of environmental regulation on different industries, different regions, and even different property rights enterprises.

(2) In addition to discussing the impact of environmental regulation on economic factors at the macro and micro levels, scholars also pay attention to the mechanism of environmental regulation causing changes in economic factors. At the macro level, many scholars have explored how environmental regulation affects macroeconomic factors by influencing intermediary perspectives such as technological innovation and industrial structure transformation. However, the mechanism of environmental regulation on macroeconomic factors is still unclear.

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(3) When discussing the impact of local environmental regulation on corporate decision- making in the region, many scholars only consider geospatial factors, mainly examining the spatial spillover effects of regional environmental regulation on neighboring regions, while ignoring the impact of regional environmental regulation on economically similar cities.

(4) The existing research still focuses on command-and-control environmental regulation and market-incentive environmental regulation, and the analysis and discussion of public voluntary environmental regulation is less, and the related research is still in the preliminary stage. On the one hand, China has not yet established a simple and efficient public voluntary feedback government affairs system. The establishment of public voluntary environmental regulation is still in its infancy, and there are few relevant practical experience and data. It is difficult to establish accurate public attention indicators on the environment, which in turn affects the effectiveness of empirical tests ; on the other hand, behind the development of public voluntary environmental regulation, there is a game among the government, enterprises and the public, which is bound to be closely related to the development of social consciousness. At present, when discussing public voluntary environmental regulation, most of the literature only considers the single impact of public voluntary environmental regulation on environmental governance. Few literatures consider the analysis from the perspective of multi-party game combined with relevant social and economic background.

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