INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 1, (2024) E-ISSN: 2222-6990

The Evolution of Chinese Environmental Regulation and its Green Innovation Effects: A Review and Prospect

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i1/20531 DOI:10.6007/IJARBSS/v14-i1/20531

Published Date: 14 January 2024

Abstract

This study reviews the evolution of China's environmental regulations and provides a literature review of the effect of environmental regulation on green innovation in China. This study provides a three-stage summary of the evolution of China's environmental regulation framework: the first stage is the initial and exploratory period of environmental legislation; the second stage is the formulation and implementation of environmental policies; and the last stage is the strengthening of multidimensional environmental regulation framework. By reviewing the evolution of China's environmental regulation framework, as well as reviewing past literature, this study finds that (1) China's environmental regulation has developed into a multidimensional framework that incorporates government command and control, market incentives, and public participation, exhibiting typical Chinese characteristics. (2) Environmental regulations are a primary driver of green innovation in China, but the findings of empirical studies are controversial because past studies have focused on different policies, regions, and industries. (3) Future research could examine the optimal combination of green innovation-oriented environmental regulation policies, the multidimensional synergy of environmental regulation framework, and the impact of policy and regional heterogeneity on enterprise behavior.

Keywords: China, Green Innovation, Environmental Regulations, Literature Review

Introduction

China is currently the world's second-largest energy consumer after the United States, and the largest emitter of carbon dioxide, with significant pressure on resources and the environment. The prioritization of heavy industry in China over the past few decades has led to rapid economic growth and exacerbated environmental issues (Guo et al., 2023). The China Ministry of Ecology and Environment reported in 2021 that 121 of China's 337 prefecture-

level cities did not meet ambient air quality standards. And China ranks 160th out of 180 countries and regions in the 2022 Global Environmental Performance Index. The Chinese government proposed at the 75th United Nations General Assembly in 2020 that China achieve peak carbon dioxide emissions by 2030 and carbon neutrality by 2060. The dual carbon target is an essential task for China over the next 40 years. The Chinese Central Government will take more robust policies and measures to facilitate the achievement of the targets. However, China's economy is still in a medium-to-high-speed development stage, and its total energy demand continues to grow. The Chinese government believes that the economy and the livelihood of its people cannot be sacrificed for the sake of emission reduction. In this context, how can the dual carbon target be achieved? How to balance ecological environment and economic growth?

Under the dual pressure of economic and environmental targets, green innovation is receiving unprecedented attention in China. Green innovation includes technologies, processes, or products that reduce environmental pollution, minimize resource and energy usage, and encompass technologies for both pollution management and climate change mitigation (Guo et al., 2023). Green innovation can protect the environment while balancing sustainable economic development. To encourage green innovation, China promotes the adoption of environmental regulations (Lin & Xie, 2023).

Environmental regulations are a series of laws, regulations, policies, requirements and standards established by governments to manage and mitigate the impact of human activities on the environment to ensure the sustainable use of resources, protect ecosystems and reduce environmental risks (Tao et al., 2021). Previous studies have focused significantly on environmental regulations as a key factor driving green innovation. How to promote green innovation in enterprises through reasonable environmental regulation is also an urgent challenge in China's current development.

This study aims to summarize the development and evolution of environmental regulation in China and investigate the effects of environmental regulation on green innovation in China through a literature review. This study provides suggestions for strengthening environmental regulation in China and promoting green innovation through environmental regulations. This study also provides an outlook on future research directions, contributing to the advancement of research on green innovation in China.

Policy Evolution of Environmental Regulation in China

The first stage: the initial and exploratory period of environmental regulation legislation (1949-1990)

The national economy began to recover with the creation of New China in 1949. During this period, the focus of government work was biased toward economic development, and no relevant environmental laws and regulations were introduced (Wu & Chang, 2020). It was not until the 1970s that the government started to pay attention to environmental issues and started investigating the possibility of using a number of administrative methods to reduce pollution in the environment. The first National Conference on Environmental Protection was conducted by the Chinese Central Government in 1973, and various policies for environmental protection and improvement were approved. Environmental protection was elevated to an institutional and legal level for the first time in China's history, formally establishing China's environmental governance system. In 1978, China incorporated environmental protection into its constitution for the first time, laying the foundation for the introduction of specific environmental protection laws. In 1979, the Standing Committee of

the Fifth National People's Congress approved the Environmental Protection Law of China. In 1983, environmental protection was formally recognized as a fundamental state policy, establishing its legal standing at the national level (Bao, 2006).

China's environmental regulations were developed from scratch at this stage, and a legal system for environmental protection was initially formed. Environmental regulation at this stage was proposed under the leadership of the Chinese Central Government and strengthening control over environmental pollution through administrative means and regulations was the most optimal mode of governance at the time. Although there was more legislation during this period, the implementation of environmental protection laws has been awkward in various places due to local governments' enthusiasm for local economic development (Tao et al., 2009).

The second stage: Environmental regulation policy development and implementation phase (1992-2008)

In 1992, China's central government set the goal of reforming China's socialist market economic system, and China's economy began to grow rapidly. Since then, China's environmental regulations have sought a balance between economic development and environmental protection. In this context, China has added environmental data to the Statistical Bulletin on National Economic and Social Development for the first time. Ten Measures for Environment and Development in China were issued by the State Council, which for the first time applied sustainable development to environmental governance. The State Environmental Protection Administration was upgraded to a direct agency of the State Council in 1988. By the end of 1996, different levels of local governments across the country had completed the establishment of environmental protection departments, and industry authorities had set up corresponding environmental management agencies. The intensity and the authority of implementation of environmental regulation were further enhanced at this stage (Wu & Chang, 2020).

During this period, China's environmental legislation broadened and became more standardized. The Chinese Central Government continued to use its authority to strengthen environmental governance and the evolution of environmental regulation in China developed rapidly.

The third stage: The upgrading stage of diversified environmental regulation policies (2008-present)

The Communist Party of China's 17th Congress suggested the development of ecological civilization as a new requirement. In this context, the Chinese Central Government has started to adopt a diversified approach to environmental governance. In 2007, the Chinese Central Government issued the National Environmental Protection Eleventh Five-Year Plan (2007-2012), which established the governance concept of optimizing economic development through environmental protection. The State Council of China established a system for the paid use of emission rights in 2014. To tackle climate change, it has advanced the creation of a national carbon emissions trading market. In the same year, the central government passed amendments to the Environmental Protection Law, which is China's strictest environmental protection law (Zhang & Cheng, 2022). Subsequently, measures for Public Participation in Environmental Protection were issued by the Ministry of Environmental Protection in order to defend the public's right to environmental protection and establish a policy foundation for citizen participation in environmental conservation.

To further promote environmental protection, in 2015, the General Office of the State Council of China issued the Measures for Pursuing Responsibility for Environmental Damage by Party and Government Leaders (for Trial Implementation). This approach refines the environmental protection responsibilities of the central and local governments, holds leading cadres accountable for dereliction of duty, and directly links environmental protection to the performance of local officials (Chen et al., 2023). Furthermore, since 2016, China's central government has conducted Central Environmental Protection Inspection to provincial local governments, to promote the implementation of local governments' primary responsibility for environmental protection. The Ministry of Ecology and Environment of China issued Measures for Central Environmental Protection Interview in 2020. The Measures provide for interviews with heads of local governments and their relevant departments, as well as relevant enterprise authorities, who fail to fulfil their environmental protection responsibilities or fail to fulfil their duties in accordance with the law. These methods further strengthen the awareness of environmental subjects and the implementation of duties in each department, reflecting the typical Chinese centralized system (Zhang & Li, 2022).

At this point, China's environmental regulation has completed its top-level design and progressed from a single command-and-control to a combined command-and-control and market-incentive environmental regulation, as well as ensuring the legal status of public participation-based environmental regulation. China's environmental regulation emphasizes multidimensional governance and is a Chinese-style environmental framework. Specific regulations and policies place greater emphasis on energy conservation and emission reduction, cleaner production, pollution control, and enterprise product catalogues.

The Effect of Environmental Regulation on Green Innovation in China

Green innovation is often viewed as a solution to both economic development and environmental crises, especially sustainable development related to energy and climate change (Hsu et al., 2021). Green innovation plays an irreplaceable role in promoting industrial transformation, enhancing energy efficiency, and reducing environmental pollution and climate change (Ullah et al., 2021).

In academics, the effects of environmental regulation on green innovation have become a heated topic of debate. The Porter hypothesis suggests that effective environmental regulation can encourage enterprises to innovate and the benefits of innovation can compensate for the costs of environmental regulation (Porter & Linde, 1995; Y. P. (Vincent) Chen et al., 2022). The Porter hypothesis provides a theoretical basis for balancing environmental and economic goals from green innovation. However, there are several different conclusions about the practice of this theory in China.

Environmental Regulation Promotes Green Innovation

Based on the "Innovation Compensation Effect" in the Porter hypothesis, the mainstream opinion is that environmental regulation can stimulate green innovation. Wang et al (2020) utilized the difference-in-differences (DID) to evaluate the efficacy of China's new environmental protection law in fostering green innovation among Chinese A-share listed companies. It was discovered that after the implementation of the new environmental protection law, there was a significant increase in green innovation. Similarly, Liu et al (2022) employed the DID to assess the effect of new environmental protection law on regional green innovation. Using panel data for 30 provincial administrative regions in China, it was found that the new environmental protection law encouraged regional green innovation. Bi & Yu

(2019) found that environmental taxes have a positive effect on the intensity of enterprises' innovation investment. Guo et al (2023) empirically analyzed the impact of environmental regulations on firms' green innovation in China's heavy pollution industry from 2006 to 2018 and found that environmental regulations play a significant role in promoting firm's green innovation in heavily polluting industries. The moderating effects analysis also reveals that environmental regulations have a greater impact on firms with weaker internal and external governance. The Foreign Direct Investment (FDI) mechanism is also one of the most common aspects of the study on the effect of environmental regulation on green innovation from the standpoint of international technology transfer. For example, environmental regulation may positively impact eco-technological innovation through FDI (Cai & Li, 2019).

Environmental Regulation Hinders Green Innovation

The view that environmental regulation hinders green innovation derives primarily from neoclassical economics, which argues that stringent environmental regulations can increase firms' costs, deplete resources for green innovation, and slow economic development (Blackman et al., 2010; Petroni et al., 2019). Shen et al (2019) examined the impact of environmental regulation on green total factor productivity in the industrial sector using a threshold regression model and found that excessive environmental regulatory intensity in heavily polluting industries hinders technological innovation. Tang et al (2020) observed that the Eleventh Five-Year Plan environmental regulations impacted firms' green innovation efficiency in the short run by lowering cash flow. Liang et al (2023) utilized panel regression to study the role of environmental policies on green innovation in 285 Chinese cities from 2010 to 2020. It was found that environmental policies inhibits enterprises' green innovation by increasing their costs and creating a resource mismatch. Luo et al (2021) analyzed panel data by the Systematic Generalized Method of Moments and found that market-based environmental regulations inhibit green innovation. Zheng & Xu (2022) analyzed the impact of environmental regulation on the green innovation efficacy of Chinese family firms. The findings suggest that market-based environmental regulation heightens the risk aversion of family businesses, thereby impeding the effectiveness of green innovation.

Non-Linear Effects

Environmental regulation and green innovation have been discovered to have a nonlinear relationship by academics. For example, Dong et al (2020) analyzed the impact of environmental regulations on green innovation in different provinces of China through a spatial panel Durbin model, and the results showed a "U" shaped pattern. Jiang et al (2022) found that there is a "U"-shaped relationship between environmental regulation and green technology innovation by incorporating the squared term into the regression model of panel data. Moreover, it was found that environmental regulations have a significant threshold effect on green technological innovation. According to Guo et al (2018), which discovered that there is a inflection point in the relationship between environmental regulation and green innovation, and that China is in the inhibition phase preceding this point. Furthermore, some scholars have discovered that environmental regulation has a V-shaped threshold effect on green innovation (Kuang & Lu, 2019), indicating that the environmental regulation at different phases has different relative strengths in terms of the compliance cost effect and the pushback effect on green innovation.

Different Effects of Environmental Regulation

Different environmental regulation policies have various effects on green innovation. At present, there are three main types of environmental regulation in China. The first type is command and control environmental regulation, which mainly emphasizes the control and supervision of pollution emission behavior by government departments through a variety of means such as regulations, laws, policies and administrative orders. The second type is market-based environmental regulation, which is characterized by the internalization of environmental externalities through the setting of prices for emissions (e.g., environmental taxes, emission fees and carbon trading systems). The third type is public participation-based environmental regulation, such as information disclosure, environmental certification, and public reporting.

Several studies have shown that the market-based environmental regulation is more effective in motivating firms' green innovation. It promotes the green transformation of industry in China more than other types of environmental regulation (Li & Xiao, 2020; Peng & Li, 2016). Studies have found that different environmental regulation tools have opposite effects on green innovation. For example, Xu et al (2022) analyzed the impact of heterogeneous environmental regulations on green energy technology innovation in China using a panel threshold model, and found that there is a positive relationship between command-and-control environmental regulations and energy technology innovation, while public participation environmental regulations have a significant inhibitory effect on green energy technology innovation. A few scholars have studied the effects of environmental regulation policy combinations. Meng & Han (2017) found that the implementation of low-carbon innovation input subsidies or carbon trading alone has a poor incentive effect on firms' low-carbon innovation behavior and does not produce the desired effect and needs to be combined with a carbon tax to play an influential role.

Several studies have investigated regional heterogeneity in the impact of environmental regulations on green innovation. For example, analyzing regional heterogeneity through regression, Xu et al (2022) identified that in regions with a high level of economic development, environmental regulations provide stronger incentives for the development of green energy technologies. Yet other studies have found that environmental regulation has a significant impact on green innovation in regions with lower levels of economic development, lower levels of education, and low to medium levels of energy consumption (Liu et al., 2022). More specifically, command-and-control environmental regulation negatively impacted green development in eastern China, while market-based regulation positively impacted green development in both eastern and western regions. In addition, public participation-based regulation has a more pronounced favorable impact on the eastern region (Feng & Chen, 2018).

Results and Discussions

The effect of environmental regulation on green innovation in China is a controversial topic, and the results of empirical studies vary widely due to differences in research perspectives, sample selection, environmental regulatory policies, and study regions. Although the existing literatures have conducted extensive studies on the effects of environmental regulation in China from multiple perspectives, there are still some shortcomings, mainly in the following aspects. First, most of previous research has analyzed the effects of a specific environmental policy. There are few studies examining how environmental regulations can be utilized to foster green innovation. Second, many studies on environmental regulation in China

evaluated the impact of specific types of environmental regulation or compared the various impacts of different types of environmental regulation on green innovation. Few studies on the policy mix and policy synergies of environmental regulation are scarce. Third, the existing literature in China focuses more on the macro- and meso-level effects of environmental regulation on green innovation and less on micro-enterprise green innovation behavior and decision-making aspects.

Conclusions

Overall, environmental regulation in China has gone through three stages. It has now evolved into a multidimensional mix of command-and-control, market-based and public-participation environmental regulation. However, there are fewer regulations and policies aimed at promoting green innovation directly. There is also a lack of legal provisions specifically supporting and protecting investments in green innovation. There is currently a gap in the role of environmental regulation in promoting green innovation in China. Therefore, it is imperative to refine environmental regulation policy design with a more precise focus on fostering green innovation.

This study makes the following recommendations for improving environmental regulation policies and for future research: firstly, to construct green innovation-oriented environmental regulations and to strengthen the relevance of environmental regulation for green innovation. Secondly, to optimize the combination of environmental regulation policies and study the effect of the combination and multidimensional synergy of environmental regulation on green innovation. Thirdly, considering the differences in environmental regulation policies, and regional and industrial heterogeneity, focusing more on the behavior of micro-enterprises.

Acknowledgments

Thank Dr. Roshazlizawati Mohd Nor and Dr. Ma Kalthum Ishak for their guidance and suggestions on this paper, and thank Xuan Li for proofreading and revision.

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