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Environmental Regulations and Environmental Performance: A Review

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Abstract **Review Article**

The rapid growth following the Industrial Revolution has led to various environmental issues. Integrating environmental management into broader strategic frameworks is essential for fostering a sustainable competitive advantage. Many countries have taken proactive steps to safeguard public environmental rights and promote sustainable economic development. This paper aims to explore the evolution of environmental regulation, the mechanisms involved, and the impact of boundary conditions on both environmental regulations and environmental performance. Additionally, we will conduct a comprehensive review of existing literature and propose potential directions for future research, with the goal of identifying effective strategies to enhance the impact of environmental regulations on environmental performance.

Keywords: Environmental Regulations; Environmental Performance; Innovation.

1. BACKGROUND

The rapid growth following the Industrial Revolution has resulted in various environmental issues, including climate change, resource depletion, and biodiversity loss. This large-scale production has posed significant challenges to the global ecosystem and humanity. As a result, global organizations must implement environmentally friendly strategies to protect the natural environment and pursue sustainable development to prevent further harm to nature. It is now widely recognized that environmental management must be integral to overall management strategy to achieve sustainable competitive advantage [1]. Environmental regulation is also acknowledged as a necessary means to address market failures [2]. Countries worldwide have adopted various environmental regulations to safeguard public environmental rights and promote sustainable economic development. Developed and developing nations have been introduced. The rapid expansion following the Industrial Revolution has undeniably led to severe environmental challenges, including climate change, resource depletion, and biodiversity loss. This extensive production poses significant threats to both the global ecosystem and humanity. Therefore, it is imperative to implement strict environmentally friendly strategies that protect our natural environment and actively pursue sustainable development to avert further damage to nature.

Recognizing that environmental management must be a core element of any effective management strategy to secure a sustainable competitive advantage is crucial. Furthermore, robust environmental regulation is vital for addressing market failures. Countries worldwide actively take bold steps by implementing environmental regulations that protect public environmental rights and drive sustainable economic development. Developed and developing nations are unwavering in their commitment to significantly reducing industrial pollution through powerful and effective environmental regulations.

The relationship between environmental regulation and environmental performance is complex, and existing studies often lack a consistent perspective [3]. This is due to the diversity of environmental regulations and the interactions between enterprises and the government [4]. This paper will explore the evolution of environmental regulation, the mechanisms involved, and the impact of boundary conditions on both environmental regulation and performance. We will conduct a review of the existing literature and propose directions for future research to uncover valuable insights into how environmental regulations can improve environmental performance.

2. The development of environmental regulations and their effects.

2.1. Command-controlled regulation

In developed countries, the government control of pollutant discharge was first adopted by a control method characterized by command and control [5]. In the 1960s, the ecological and environmental problems brought about by the industrialization of Western countries became increasingly worse, and people's awareness of environmental protection revived. Rachel Carson's book *Silent Spring* vividly suggested the environmental crisis in the United States, which aroused huge social repercussions, and the U.S. government began to pay attention to formulating and implementing environmental laws and regulations. By issuing and enforcing rigid environmental regulations and standards, the administrative authorities directly specify what is allowed and prohibited in an industry or economic activity and punish those who break the rules to curb the negative impact of enterprises' production and operation activities on the environment.

In the 1960s and 1970s, the US government issued dozens of environmental protection laws and hundreds of regulations and standards [6]. During this period, command-control environmental regulation was mainly implemented. The Clean Air Act promulgated by the US federal government in 1963 was the first primary environmental law in the United States to control air pollution. The Water Quality Act of 1965 required states to establish water quality standards and specific implementation plans to meet these standards [7]. The National Environmental Policy Act of 1969 established the institutional framework for environmental protection in the United States. In 1970, the United States established the Environmental Protection Agency (EPA), which is responsible for enforcing various environmental regulations and standards set by the government. To strengthen the cleanup of closed and abandoned hazardous waste sites, the Comprehensive Environmental Response, Compensation, and Liability Act of 1978, also known as the Superfund Act, set specific requirements for the cleanup of hazardous waste sites, including site assessments, surveys, and cleanup plans. Determine the joint liability of the responsible person and potential responsible party (PRP) for identifying and cleaning the toxic discharge site. To cooperate with implementing environmental protection regulations, the United States government has also formulated detailed environmental standards, including surrounding, emission, and technical standards.

Effects: Command-control regulation has distinct administrative characteristics. Although it can achieve environmental objectives quickly, it also has many disadvantages. Due to the rigid and strict environmental policies mainly based on mandatory management measures, the cost of enterprises and the impact on society and the economy should have been considered. They could not be triggered by the anti-environmental protection movement, which hindered the further development of environmental protection in the United States. Command-control environmental regulation is an administrative means that uses the supreme power of the state to impose constraints and economic penalties on enterprises that violate environmental protection requirements. To reduce the cost of environmental regulation, some enterprises will take technological innovation measures to improve environmental quality while obtaining economic benefits such as cost reduction and green product premiums [8].

2.2. Market-Incentivized Regulation

Since the 1980s, the United States has introduced market-incentivized regulation, mainly of two types: pollution charges (or environmental taxes) and environmental subsidies. The second is tradable emission permits [9]. This means of control makes full use of the role of market prices and other economic variables and requires enterprises to bear the cost of pollution control activities while taking responsibility for the consequences of environmental damage, even if the external environmental costs are internalized. As early as the 1960s, the American economist Dale (1968) took the lead in publishing the conceptual framework of carbon trading emission rights, and the transformation of the definition of emission rights formed the central concept [9]. The definition of carbon trading is the quantification of carbon dioxide quotas and the formation of a market mechanism as a commodity traded between enterprises. In 1977, the US Clean Air Act Amendment Act confirmed the quantity-based trading mechanism by law. In the United States, the sulfur dioxide trading program was introduced in the Clean Air Act of 1990, and the Acid Rain Project proposed in Section 4 of the Act is a successful case of using the emission permit market to trade [10].

The Clean Air Act of 1990 also required states to use permit fees to offset administrative costs incurred by programs on permits. According to the amount of pollution discharged, the polluter pays the corresponding fee to the management department to obtain the discharge permit. The United States does not directly adopt the sewage tax system. Still, it uses user fees or product fees, such as sewage treatment fees levied on enterprises that discharge sewage to municipal sewage treatment facilities and fees levied on cars that use gasoline.

Western countries, including the United States, also extensively use environmental subsidies such as government tax incentives and direct subsidies for environmental protection equipment and pollution control activities to control pollution emissions. Government buyback means that the government directly pays a certain amount for product recycling; for

example, eliminating old high-polluting cars will receive government subsidies [11].

Effects: Market-incentivized regulation does not force enterprises to use specific technology to reduce emissions, nor does it require the mathematical consistency of enterprise emission reduction, so it gives polluters more space for independent choice and encourages them to minimize emission reduction costs through independent development of new technologies. Therefore, market-incentivized regulation can enable the private to achieve the goal of environmental policy and obtain good social benefits while pursuing their interests. Although incentive environmental management is beneficial to improve control efficiency and reduce control costs, some things could be improved in the implementation process. For example, to implement the sewage fee policy, the government departments need to comprehensively consider the relevant cost and benefit factors and set and constantly adjust the sewage fee tax rate, which will inevitably affect the distribution of income and wealth, resulting in games and political battles between the government and enterprises.

2.3. Voluntary Regulation

With the public's concern for environmental protection issues, the institutional framework for government, enterprises, and social groups to jointly manage environmental issues has gradually formed, and the core of joint governance is to share environmental information. From the late 1980s to the 1990s, the requirements for environmental information disclosure were introduced intensively in the United States, marking a new historical stage of environmental control policy in the country [12]. Environmental information disclosure has gradually evolved into a way to protect the public's rights and interests in environmental information. At the same time, it also constitutes an essential supplement to the two basic environmental management methods. In the market environment of asymmetric information, the lack of information on pollution will lead to environmental management and control failure based on laws and regulations and the market. Disclosure control plays a role through the information disclosure mechanism, which does not directly interfere with the production and operation of enterprises, nor does it require the emission enterprises to pay fees, so the cost pressure of enterprises is relatively low.

The first environmentally friendly product certification was created in Germany in 1978 under the name "Der blue Engel." In 1992, the European Commission issued the Ecolabel Regulation, which certifies products and services that reduce their environmental impact. The same year, the British Standardization Institute (BSI) officially published the BS7750 environmental management system standard. Subsequently, the European Community published (EEC) No.1836, "Regulation on the Intention of Industrial Enterprises to Participate in the Joint System of Environmental Management and Environmental Audit," in 1993 concerning the BS7750 standard. Since then, Canada and other countries have set similar standards. Under the support of these standards, European and American countries began to implement environmental audits, which proved the organization's environmental performance by third-party certification. These practices laid the foundation for the ISO14000 series of standards. In 1996, the International Organization for Standardization (ISO), the world organization for Standardization, published the ISO 14001 Environmental Management System Standard, a voluntary communication tool organizations have to ensure compliance with specific environmental parameters. Its ultimate goal is to voluntarily reduce the environmental impact of its activities [13]. A good example is ISO 14001, the most widely analyzed and implemented voluntary environmental standard. It provides practical tools for companies and organizations looking to manage their business's environmental impact better. There are more than 300,000 ISO 14001 certifications in 171 countries worldwide. Since its publication in 1996, the ISO 14001 standard has grown steadily worldwide, except for a period around the time of the economic crisis when the number of certifications dropped: at the beginning of 2007, 128,211 certificates had been issued worldwide, and three years later, in 2010, the number reached 222,794. Growth over the same period was 14 percent [14].

Effects: The facilities of certified organizations can reduce carbon emissions compared with non-certified organizations' facilities [15]. Voluntary regulation encourages enterprises to actively participate in environmental governance through non-mandatory methods, such as social responsibility and ecological awareness, so enterprises can use limited resources more reasonably to innovate technologically. And make money from it. Although voluntary regulation is not mandatory, it can give enterprises more excellent initiative in environmental governance and stimulate their social responsibility and innovation willingness. Over the past two decades, environmental certifications such as ISO 14001 and the Eco-Management and Audit Program certification have come a long way [16]. Song *et al*., (2024) analyzed the economic benefits of ISO 14001 certification by assessing production efficiency among South Korean manufacturing firms. Using a stochastic frontier model with endogeneity, they found that ISO 14001 certification boosts technical efficiency in high-polluting industries, leading to an average output increase of 2.7% [17]. A range of potential moderating effects were also identified, such as a more pronounced positive impact on adopting environmentally-based innovations and on companies with more mature certifications [18].

3. The mechanism of environmental regulation on environmental performance

Academic circles have extensively discussed how environmental regulations affect environmental performance, focusing on product, technological, institutional, and ecological innovation perspectives. We will summarize from these four aspects:

3.1. Mediating role of product innovation

Compared with traditional product innovation, environmentally friendly product innovation helps to reduce or avoid the environmental burden. As a result, product innovation can improve resource utilization efficiency, increase return on investment and sales, open new markets, and increase environmental performance [19]. Therefore, environmental regulation can motivate enterprises to carry out product innovation. Kammerer's (2009) study clearly shows that customer benefit and environmental regulation play a key role in production innovation. They foster the implementation of production innovations, their broad application, and their level of novelty applying to German manufacturers of electrical and electronic appliances [20]. Rennings & Rammer (2011) found that product innovations driven by environmental regulation generate success in sales with new products and cost savings as other innovations using firm data from the German innovation survey [21]. Dangelico's 2016 review includes 63 studies showing that various factors drive GPI development, both internal and external to the firm, with environmental regulations being the most significant external factor [22].

Hu *et al*., (2017) conducted a study using data from 35 industrial sectors in China from 2001 to 2010 to examine the effect of environmental regulation on performance. The results indicate that while both process and product innovation act as mechanisms linking environmental regulation to performance, environmental regulation plays a more significant role in enhancing firm performance through product innovation [23].

3.2. Mediating role of technological innovation

Technological innovation is forming new ideas to utilize and produce products or services to meet the market's needs—the promotion, diffusion, and application of innovation results. Hashmi and Alam (2019) studied the impact of environmental regulations and technologies on carbon emissions, found that environmental regulations are more effective than environmental technologies in reducing CO2 emissions, and found that when environmental taxes per capita are increased by 1%, CO2 emissions are reduced by 0.03% [24]. Ulucak *et al*., (2020) took Brazil, India, China, Russia, and South Africa as research objects. They found that current environmental regulations are effective for these countries to achieve pollution reduction targets, confirming the positive role of environmental regulations in reducing carbon emissions [25]. Li *et al*., (2020) state that government environmental regulations on resource-based industries will force technological innovation in resource-based industries. This paper selects panel data from 12 resource-based industries in China from 2003 to 2019. It constructs an econometric model to test the impact of environmental regulations on technological innovation in resource-based industries. The results show that environmental regulation can promote technological innovation in resource-based industries. Environmental regulation improves environmental performance by stimulating innovation [26].

These results suggest that the demand for environmental technologies depends heavily on the extent to which environmental regulation can correct market failures. Without environmental regulation, the need for technological innovation will be significantly reduced. Therefore, environmental regulation is a catalyst for enterprises to carry out technological innovation and enhance their environmental performance by promoting technological progress.

3.3. Institutional Innovation

Institutional innovation refers to changes in the enterprise system, such as the organization's design, which can affect the innovation of the enterprise at different levels through the quantity and quality of information exchange. This indicates that the internal system of an enterprise largely determines the impact of environmental regulations on environmental performance. Poor enterprise systems can lead to profit-oriented business models in the short term, thus hindering the innovation and dissemination of environmental technologies. In contrast, sound enterprise systems can promote a firm's long-term strategy, thus promoting technological innovation and product innovation.

O'Rourke (2004) found that some environmental regulations require enterprises to conduct self-evaluation and process improvement, which is crucial for promoting enterprise reflection and environmental innovation [27]. Tarui and Polasky (2005) point out that since environmental regulation was a means of responding to pollution at the time, environmental regulation may change with changes in environmental quality or consumer environmental requirements [28]. Forward-looking enterprises will consider this relationship when responding to the government's environmental regulation goals so that the environmental strategy of enterprises will fully consider future expectations. From this perspective, businesses that do not have a long-term perspective are always reactive when responding to changes in environmental regulations, and the compliance costs they face can be significant in the long run. Therefore, environmental regulation is a spur to the institutional design of enterprises.

Baron and Tang (2011) point out that if the impact of environmental regulation on enterprise organization and design is ignored, the research results on the impact of environmental regulation on innovation may need to be completed [29]. This finding reveals that environmental regulation can not only directly affect technological innovation through its impact on enterprise institutional innovation but also indirectly affect technological innovation through its impact on enterprise institutional innovation. When entrepreneurs recognize the economic importance of environmental performance and benefit from such investment, traditional anti-competition measures, such as property rights protection, product, and factor market regulation, will enhance the shaping of enterprise culture and promote organizational change [30].

Therefore, environmental regulation increases the enterprise's voluntary adoption of better implementation business opportunities through the internal factor innovation of the enterprise system. Ashok *et al*., (2021) believe that budget capacity, organizational constraints, incentives, and operational inertia are critical internal factors in organizations. Establish a complete environmental management system, such as ISO140001 and other international standards, to ensure the standardization and systematization of enterprise environmental management, develop and implement environmental management systems and operational processes, and clarify each department's environmental management responsibilities and objectives. Develop environmental response strategies, including emergency plans, risk prevention measures, etc., to ensure enterprises promptly respond to environmental risks.

3.4. The mediating of Ecological innovation

An enterprise ecosystem is a mutually supportive system of consumers, suppliers, major producers, financial institutions, governments, and other stakeholders. The competition and cooperation among various entities in the enterprise ecosystem can promote knowledge spillover among enterprises, thus improving the innovation supply ability of enterprises [32].

Carbon trading can impact the performance of downstream companies through cost effects and spillover effects within the industrial chain. Using data from listed companies, Jia (2023) has developed an innovative three-dimensional dataset that includes "upstream firm - downstream firm - time," comprising a total of 40,437,001 valid observations. The findings indicate that the effects of carbon trading on downstream performance are negative in the short term, while in the long term, they show a positive significance. You *et al*., (2019) believe that environmental regulation can significantly promote the ecological investment and ecological planning innovation of industrial enterprises without being affected by the political system of the government, which is of great significance to the sustainable development of China's economy [34]. The group of enterprises in the enterprise ecosystem may form a community of profit and loss.

When the intensity of environmental regulation is increased, it will lead to a linkage effect among enterprises in the ecosystem. The leading enterprises bear the brunt and take the lead in investing in green products and green technologies. Because strict environmental regulation has gradually become the trend of social development, taking the lead can seize the opportunity in future competition. On the other hand, any enterprise has specific social and environmental responsibilities. This motivation for environmental innovation leads to raw demand from other firms in the enterprise ecosystem, resulting in green technology innovation in vertically related industries or horizontal enterprise alliances.

Therefore, environmental regulation can be regarded as an external influence on enterprise ecology, forcing enterprises to cooperate and promote innovation in enterprise ecology, thereby improving environmental performance. Drawing on the contingency theory, Geng *et al*., (2021) developed and tested a model that categorizes small and medium-sized manufacturing enterprises (SMMEs) into clusters based on their eco-innovation levels. The study reveals that performance improvements from eco-innovation depend on the firm cluster and environmental management practices, such as internal source reduction and external compliance. Analyzing survey data from 382 SMMEs in China, the researchers found two clusters: 225 SMMEs (58.9%) were eco-innovation adopters, while 157 (41.1%) were eco-innovation planners. T-test results indicated significant differences in eco-innovation implementation, environmental management, and performance improvements between the two groups. Additionally, external compliance and communication enhanced management innovation and environmental performance among planners. Implementing regulations can also drive innovation in upstream enterprises, accelerating overall industrial chain upgrades.

4. Heterogeneity of environmental regulation on environmental performance

4.1. Negative effect of environmental regulations on environmental performance

Inadequate environmental policies can create the "green paradox," in which well-intentioned policies encourage resource owners to increase resource extraction due to inadequate alternative energy subsidies and lagging implementation, leading to an increase rather than a decrease in current polluting emissions [36]. For some enterprises, the strengthening of environmental supervision increases the production cost of enterprises and ultimately inhibits the upgrading of industrial structures [37]. Chen *et al*., (2022) discussed the

economic impact of environmental regulations on different aspects of market structure. They believed that environmental regulations increased enterprises' production costs, thereby squeezing enterprises' profit margins and reducing their production efficiency. This will affect enterprises' entry and exit behavior and ultimately negatively impact the industrial structure [38]. Sinn (2008) points out that if fossil fuel suppliers feel the potential threat of gradual implementation of national environmental policies, they will exploit fossil fuel reserves faster, thus accelerating global warming [39].

He *et al*., (2022) pointed out that under the influence of fiscal decentralization, to maximize their own interests, local governments have a "race to the bottom" in formulating and implementing environmental regulatory policies, which is not conducive to reducing agricultural carbon emission intensity [40]. Zhang *et al*., (2021) note that local governments in China have diversified competitive behaviors in implementing environmental regulations, resulting in the transfer of pollution to nearby areas and increasing local CO_2 emissions [41]. Some scholars believe that China's current environmental regulation is still in the stage of a green paradox [42]. The differences in environmental standards between regions, polluting enterprises move from areas with strict environmental requirements to areas with looser environmental regulations, resulting in deteriorating environmental quality in the transferred areas. Kheder and Zugravu (2012) provided evidence for the pollution haven hypothesis by analyzing the impact of environmental regulations on the location selection of manufacturing enterprises in France. They argue that manufacturing in France is more likely to move to other countries with looser environmental regulations, making those countries potential pollution havens [43].

4.2. Nonlinear effects between environmental regulation and environmental performance

Different from the above two viewpoints, some studies have found that the relationship between environmental regulation and environmental performance is not linear. You *et al*., (2019) believe that under the influence of a fiscal decentralization system and political promotion champion, environmental regulation significantly inhibits ecological innovation, ecological planning innovation, and ecological investment [34]. Hao *et al*., (2018) mentioned that China's current environmental supervision method has not achieved the expected effect. They proved that environmental supervision can effectively curb pollution emissions only when foreign direct investment is controlled [44]. Du *et al*., (2021) belie ve that when the level of economic development is low, environmental regulations have no significant impact on the upgrading of industrial structures and, at the same time, inhibit the innovation of green technology [45]. Only when the level of economic development is high will environmental regulation significantly promote green technology innovation and industrial structure upgrading, thus accelerating the process of economic green transformation. The study of Song *et al*., (2020) confirmed the U-shaped relationship between environmental regulation and green product innovation. With increased environmental regulation intensity, its effect on green product innovation changes from inhibition to promotion [17]. Chen *et al*., (2019) pointed out that environmental regulations and industrial structure have apparent nonlinear effects on carbon dioxide emissions; that is, the impact of environmental regulations on carbon emissions changes with the rationalization of industrial structure [46]. Chen and Qian (2020) discovered that different marine environmental regulations have a positive U-shaped relationship with the upgrading of manufacturing structures and the relocation of polluting industries. Notably, the inflection point for the upgrading of industrial structures occurs later than the relocation of these polluting industries [47].

Through in-depth research, especially after the green paradox theory was put forward, scholars have questioned the necessity and effectiveness of environmental regulation in improving environmental quality [48]. Due to the imbalance of its industrial development, the degree of pollution discharge is quite different, which leads to different effects of environmental policies. In addition, implementing environmental regulatory policies may also lead to relocating industries to different regions, further complicating China's industrial pollution situation. Therefore, whether environmental regulation can effectively promote China's industrial green transformation to impact environmental performance positively depends on different boundary factors.

5. Boundary effects of environmental regulation on environmental performance

5.1. Enterprise Size

Due to their more extensive scale, large enterprises usually have more resources and a stronger ability to cope with environmental regulations. At the same time, large enterprises often have a more perfect organizational structure and more professionals, and they can invest more money in the research and development of green products, improve technology, or enhance environmental standards to meet or exceed the requirements of environmental regulations. In addition, large enterprises often face more social responsibility and public expectations. As a result, they may be more motivated to innovate within environmental regulations to protect their environmental image and social responsibility [49]. Due to limited resources, small enterprises may pay more attention to short-term survival and profit, so the impetus for innovation under environmental regulations may need to be stronger. Environmental policies will also restrict technological innovation. Because environmental protection, energy

saving, resource utilization, and other technologies are high-cost, the capital and time invested by enterprises have high requirements. For some small and developing enterprises, it is tough and challenging to carry out technological transformation and technological innovation. This also leads to some enterprises meeting the environmental protection policy at the same time but also need to face more cost pressure [50].

5.2. Social Capital

Enterprise social capital helps companies obtain information on environmental regulatory policies, green technologies, and market dynamics. By connecting with governments, industry organizations, research institutes, and other businesses, companies can keep abreast of the latest developments in environmental regulation and adjust their green innovation strategies. Through communication with government departments, enterprises can understand the background and purpose of policy formulation and the specific requirements of policy implementation [51]. This helps enterprises to prepare in advance, avoid compliance risks, obtain more policy support and incentives, and create a better external environment for green innovation. In addition, enterprise social capital can also promote resource sharing, including technology, capital, talent, etc., and provide necessary resource support for green innovation, which helps enterprises and stakeholders to establish and maintain the trust relationship between enterprises and promote cooperative innovation. When companies establish stable cooperative relationships, they can share resources, share risks and jointly develop green technologies and products. This collaboration will not only help reduce the cost of green innovation but also improve the efficiency and quality of innovation and promote enterprise environmental performance. At the same time, environmental regulation is often accompanied by certain uncertainties and risks. Enterprise social capital helps companies better cope with these uncertainties and risks [52]. By working closely with partners, suppliers, and customers, companies can share risks and reduce the uncertainty of green innovation. At the same time, enterprise social capital can help enterprises obtain market feedback quickly and adjust innovation strategies to cope with market changes.

5.3. Senior Executives

Senior executives hold strategic decision-making authority, allowing them to determine how companies respond to environmental regulations and the strategies they employ [54]. Consequently, senior executives play a crucial role in shaping the impact of environmental regulations on an enterprise's performance. When environmental regulations become stricter, senior executives can increase investments in environmental initiatives, enhance production processes, reduce pollution emissions, and improve overall environmental performance. These decisions ensure compliance and help establish a positive environmental image for the enterprise, which can enhance its social reputation. Additionally, senior executives can implement internal regulations and incentives to engage employees in environmental protection efforts. They might establish environmental performance indicators and incorporate environmental activities into the employee performance appraisal system to foster greater awareness and responsibility among staff.

Moreover, senior executives can enhance their understanding of environmental regulations through training and awareness campaigns, ensuring the smooth execution of environmental initiatives within the enterprise. By maintaining close contact with government entities and industry associations, they can stay informed about the latest environmental policies and industry trends. This engagement enables them to participate in formulating environmental policies and industry standards while advocating for more resources and support for the enterprise, ultimately fostering a favorable external environment for business operations. Leadership is closely related to green innovation and green creativity [55]. Sun *et al*., (2022) found that environmental leadership positively moderates corporate environmental ethics and green innovation [56].

5.4. Public Media

Public media provides unprecedented transparency, making it easier for the public to access and share information about inconsistencies in the enterprise environment. Such transparency increases public scrutiny of enterprises and can taint competitors' reputations. When an enterprise is penalized for failing to comply with environmental regulations, its competitors may face greater scrutiny and comparison due to public scrutiny of the industry. The pressure of public opinion on public media can quickly affect the brand image and consumer trust of an enterprise, and its competitors may take the opportunity to strengthen their brand image construction and win the favor of consumers by emphasizing their environmental responsibility and social responsibility. When an enterprise loses market share due to an inconsistent environment, its competitors will likely fill the void and expand their market influence. This change could lead to a shake-up of the entire industry, allowing enterprises that proactively address environmental challenges and demonstrate social responsibility to stand out in the market. Li *et al*., (2023) find the new media environment can motivate heavily polluting enterprises to meet stakeholder demands and significantly improve their corporate green technology innovation.

6. Research in the Future

The relationship between environmental regulation and enterprise environmental performance is a complex and multi-dimensional research field that will be interfered with by many external factors.

Nevertheless, environmental regulation is a standard administrative means in developed and developing countries based on the environmental pressures and challenges in industrialization and urbanization. To improve the effectiveness of environmental regulation on the environmental performance of enterprises, it is necessary to study the following issues further to promote environmental regulation policies to better respond to environmental changes and improve the competitiveness of enterprises.

First, an assessment of the effect of environmental regulation is needed. Assess the impact of different environmental regulations (such as emission standards, taxes, subsidies, etc.) on enterprise environmental performance and the applicability of these policies in different contexts. Study the synergies between environmental regulation and other economic policies (such as industrial policies, trade policies, etc.) and the effects of these synergies on enterprise environmental performance.

Second, Cross-industry and transnational comparative research. Conduct cross-industry and cross-country comparative research to explore the differences and commonalities of environmental regulation and environmental performance in different industries and regions. Based on the needs of international development, enterprises need to operate in multiple regions and countries, and the environmental regulation standards of countries or regions may differ, increasing the complexity of enterprise compliance. Through cross-industry and cross-border comparative analysis, the key factors and successful experiences affecting environmental performance can be found, which can provide a reference for formulating more targeted environmental policies and promoting the environmental performance of enterprises.

Third, the mutual influence of environmental regulations on both environmental performance and economic performance should be explored further. That is to say, how can enterprises achieve a win-win situation by complying with these regulations while also enhancing their economic performance? Additionally, examining the mechanisms that allow enterprises to attain both environmental and economic goals simultaneously is necessary. That will involve considering different effects during the early, middle, and later stages of implementing environmental regulation across various life cycles of enterprises.

Fourth, the analysis may focus on how enterprises adjust their strategies, technologies, and operations in response to environmental regulations and how these adjustments may impact their environmental and economic performance concurrently. Furthermore, it calls for a more diverse range of research methodologies. Future studies could include longitudinal and case studies that investigate the long-term relationship between industries and the performance of enterprises in the context of environmental regulation. In-depth analyses of both the successful experiences and lessons learned from failures of enterprises engaged in green innovation under such environmental regulation would provide valuable insights for other enterprises.

Fifth, the construction of the theoretical framework should be further expanded. Current research still needs to be improved in constructing a theoretical framework, and it is necessary to explore further the internal relationship and causality between environmental regulation and enterprise performance. There is a need to develop a more comprehensive and systematic theoretical framework to help enterprises assess the impact of environmental regulations and develop effective coping strategies.

In summary, there are still significant opportunities for development in the research area concerning the impact of environmental regulations on future enterprise environmental performance. By conducting in-depth studies on various aspects and actively addressing the current gaps, we can create meaningful improvements and drive progress, ultimately offering stronger support and guidance for sustainable enterprise development and environmental protection.

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