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Research of the Impact of Heterogeneous Environmental Regulation on the Performance of China's Manufacturing Enterprises

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Promoting high-quality economic development with high-level ecological protection is one of the most important tasks in China's new stage of development. The improvement of enterprise performance is the micro-foundation of high-quality economic development, while environmental regulations aim to reduce the negative effect of economic development on the environment. Consequently, the microeconomic effects of environmental regulation have received widespread attention in academia. Previous studies have emphasized the effect of environmental regulations on firm performance but have not reached a consensus and lack of insight on the combined effects of different types of environmental regulation. This study aims to fill this gap by considering the heterogeneity of environmental regulations and the effect of the interaction between heterogeneous environmental regulations on enterprise performance. To reveal the relationship between the different types of environmental regulations and the performance of manufacturing enterprises, and the possible impact mechanism, this study uses the fixed effect model to test the impact of different environmental regulations on the performance of manufacturing enterprises, the mediation effect model is used to check whether or not an environmental regulation affects the performance of manufacturing enterprises by improving the level of technological innovation of enterprises, and the moderating effect model is used to examine the impact of the interaction between different environmental regulations on the performance of manufacturing enterprises. The results show that command-and-control environmental regulation inhibits the performance improvement of manufacturing enterprises, while a market-based environmental regulation enhances performance by improving the technological innovation level of enterprises. Market-based environmental regulation will alleviate the disincentive effect of command-control environmental regulation on the performance of manufacturing enterprise.

Keywords: heterogeneous environmental regulation, enterprises performance, technology innovation, interactive effect, development

1 INTRODUCTION

Responding to climate change and the ecological environment protection are inherent requirements for sustainable economic development. As a developing country, China's ranking as the world's largest manufacturing country has attracted worldwide attention. At the same time, environmental pollution has undoubtedly become an important bottleneck that has restricted the sustainable and high-quality development of China's economy. According to the *2020 Global Environmental Performance Index (EPI) Report* that was released by Yale University, China ranks 120 out of the 180 participating countries. This shows that China's environment is in urgent need of improvement. Consequently, improving the environment has become one of the most important tasks to promote high-quality economic development with high-level ecological protection in China's new stage of development. In this context, it is significant to study the question of whether or not environmental regulation can promote high-quality economic development, while also reducing pollution and protecting the environment. The improvement of enterprise performance is the micro-basis of high-quality economic development. Therefore, the research objectives of this study are to explore the impact of heterogeneous environmental regulation on the performance of manufacturing enterprises and the possible impact mechanism and to further study the impact of the interaction between different environmental regulations.

Enterprise performance describes the operating efficiency and operator's performance of an enterprise during a certain period of operation. The level of operating efficiency is mainly reflected in profitability, asset operation level, debt repayment ability, and follow-up development ability (Teece, 2007). A large number of studies have explored various determinants of enterprise performance. Among the most recent literature, Usama Awan et al. (2021) have demonstrated that big data analytics can stimulate manufacturing performance (Awan et al., 2021). However, research of the impact of environmental regulation on enterprise performance mainly focuses on the "Porter Hypothesis" (Porter, 1991; Porter and Linde, 1995). Although total factor productivity (TFP) can be used as one of the manifestations of enterprise performance, research of the impact of environmental regulation on the TFP has not yet reached a unified conclusion. Environmental regulation comes at an additional cost to firms, which may erode their global competitiveness (Shen et al., 2019). Zhang et al. (2020) argue that well-designed environmental regulations may lead to a "win-win" situation in some cases by not only protecting the environment but also enhancing profits and competitiveness through the improvement of products or their production processes (Zhang et al., 2020). From the TFP perspective, the impact of environmental regulation on a firm's performance may depend on the type and extent of regulation. Therefore, it is uncertain that the existing environmental regulations can definitely improve enterprise performance. Enterprise innovation level is an important basis for enterprises who wish to achieve high-performance development (Tao, 2020; Wang et al., 2022). What factors affect enterprise innovation? Interorganisational collaboration can significantly improve a manufacturing firm's innovation (Awan and Sroufe, 2020), while at the same time a firm's innovation can effectively reduce emissions of CO_2, thereby optimizing the quality of the environment (Cheng, 2021). Therefore, based on the perspective of improving the quality of the environment, Jaffe and Palmer (1997) first distinguished between the strong, weak, and narrow versions of the PH. The strong version of the PH argues that environmental regulation induced innovation more than offsets any additional regulatory costs in many cases, thus leading to an increase in a firm's competitiveness. The weak version of the PH states that although properly designed environmental regulation may spur innovation, it does not indicate whether that innovation is good or bad for firms. The narrow version of the PH emphasizes that certain types of environmental regulation simulate innovation.

The Porter Hypotheses has triggered a large body of empirical studies, which mainly focus on the empirical test of the strong PH and weak PH but present mixed results. Early studies investigating the strong PH mostly conclude that environmental regulations cause a loss of productivity (Barbera and McConnell, 1990; Gray and Shadbegian, 2003; Rubashkina et al., 2015), which may reduce the performance. More recently, many studies have focused on the link between environmental regulation and performance, and have provided clearer support for strong PH (Lanoie et al., 2010; Rubashkina et al., 2015; Ramanathan et al., 2016). Some researchers have tested the weak PH, which is a relationship between environmental regulation and innovation, and found that how environmental regulation influences innovation depends on the degree of regulation (Brunnermeier and Cohen, 2003; Johnstone et al., 2008; Kneller and Manderson, 2012; Yabar et al., 2013). Although most of these studies find that environmental regulation has a positive effect on innovation, it is uncertain that this innovation can promote a firm's performance (Ambec et al., 2013). Only a small number of studies have simultaneously examined the relationships between regulation, innovation, and performance. These studies simply run regression tests on the relationships between environmental regulation and innovation, and between innovation and performance.

From the content of this literature, we can find the following deficiencies in the previous studies. First, most of the previous studies focused on the role of a single environmental regulation tool. Although some studies have discussed the impact of heterogeneous environmental regulation on the location choices of pollution-intensive firms (Tang and Dou, 2021), only a few studies have directly examined the economic effects of heterogeneous environmental regulation on firms. Second, these reviewed studies have not yet determined that technological innovation has played the mediating function between environmental regulations and manufacturing enterprise performance. Therefore, we will use the mediation effect model to explore the impact mechanism of environmental regulation on firm performance. Finally, the implementation of different regulatory tools may affect their roles. Consequently, we will study how their interactive effects may influence the

enterprise's performance. This study attempts to open the "black box" where heterogeneous environmental regulation promotes enterprise performance and conducts a comprehensive empirical test based on the firm-level data of China's manufacturing enterprise.

The goals of this study are to enrich the literature on environmental, economic, and business management. To meet the goals of this study, we focus on the impact of heterogeneous environmental regulation on an enterprise's performance. We aim to answer the following questions. First, can environmental regulation become the external "Booster" for enterprise performance improvement? Second, do different types of environmental regulation have heterogeneous effects on the enterprise's performance? Third, does technological innovation play an intermediary role in the process of environmental regulation by promoting the performance of manufacturing enterprises? Finally, are there any interaction effects between different types of environmental regulations? The answers to these questions may help to perfect environmental regulation policy, thus achieving a win-win situation between environmental protection and high-quality economic development. The conclusions of this study not only lay the theoretical foundation for government departments to formulate environmental regulation tools but they also provide empirical support and policy suggestions for relevant departments to reasonably take regulatory measures.

The rest of this article is arranged as follows. The second part analyzes the current situation of heterogeneous environmental regulation in China and it describes its influence mechanism on enterprise performance. The third part introduces the empirical methods and data that we used in this research. The fourth part describes the empirical results and analysis. The final part concludes and provides some policy implications.

2 HETEROGENEOUS ENVIRONMENTAL REGULATION IN CHINA AND ITS IMPACT ON ENTERPRISE PERFORMANCE

2.1 Heterogeneous Environmental Regulation in China

Environmental regulation refers to relevant laws and regulations that have been formulated by the government and local regulatory authorities to protect the ecological environment and achieve sustainable economic development (Chai et al., 2020; Lei et al., 2021; Tang and Dou, 2021; Gao et al., 2022). Generally, China's environmental regulations are divided into formal and informal environmental regulation. Laws and regulations promulgated and implemented by the government are considered to be formal environmental regulations, which include command-and-control environmental regulation and market-based environmental regulation. In contrast, regulations implemented by the public and environmental protection organizations driven by public environmental awareness are considered to be informal environmental regulations, which include public environmental regulations and voluntary environmental regulations. Because of the indirect and hysteretic effect of the informal environmental regulation (Li and Ramanathan, 2018), formal environmental regulation has been shown to be the most effective policy tool to control environmental pollution in China (Wang, 2016). Therefore, the following subsections will focus on the two forms of the formal environmental regulation, namely command-control environmental regulation (CER) and market-based environmental regulation (MER).

2.1.1 Command-Control Environmental Regulation

CER can be divided into the command type of prior guidance and regulatory type of post-punishment. The command type refers to the direct management and compulsory supervision of production behaviors by national administrative departments according to the relevant laws, regulations, rules, and standards. For example, if the production conditions of the enterprise do not meet the technical standards of pollution emission as stipulated by the relevant national laws and regulations, then the enterprise must stop production. In addition, if the design standards of the investment project do not meet the national basic environmental protection technology standards, then they will not be allowed to start construction. Since the official enactment of the Environmental Protection Law of the People's Republic of China in December 1989, China's legislative organs and administrative departments have issued a series of laws and regulations related to environmental protection. As of 2019, a total of 64 laws and regulations have been issued at the national level, and 2,019 laws and regulations have been issued by all provinces in China (approximately). From the perspective of regional differences (**Figure 1A**), governments in eastern China pay more attention to environmental protection than any other regions of China, with the highest level of command environmental regulations. In particular, the number of environmental regulations in eastern China increased from 245 in 2010 to 352 in 2019, or an increase of 43.7%. In contrast, there were 247 environmental protection regulations in western China in 2019. The central region had a relatively low level of command environmental regulations, with only 135 environmental regulations in 2019.

Regulatory environmental regulation requires that national and local environmental protection departments supervise and manage the production behavior of enterprises. If an enterprise's after-production emission fails to meet the national standard, then they will be obliged by the government to rectify and upgrade the production-line or stop production. Currently, China primarily relies on the staff at emission monitoring stations and testing equipment to sample and test pollutants during and after production. **Figure 1B** shows that the number of environmental regulation staff in eastern, central, and western regions of China has increased from 1.259 million, 0.482 million, and 0.561 million to 1.4533 million, 0.5618million, and 0.6025 million, respectively, during the last decade. This suggests that the level of regulatory environmental regulation in the eastern region ranks the first in China, followed by the western region and the central region. This is mainly due to the large scale of industry in eastern China and the widespread distribution of industry in western China. At present,

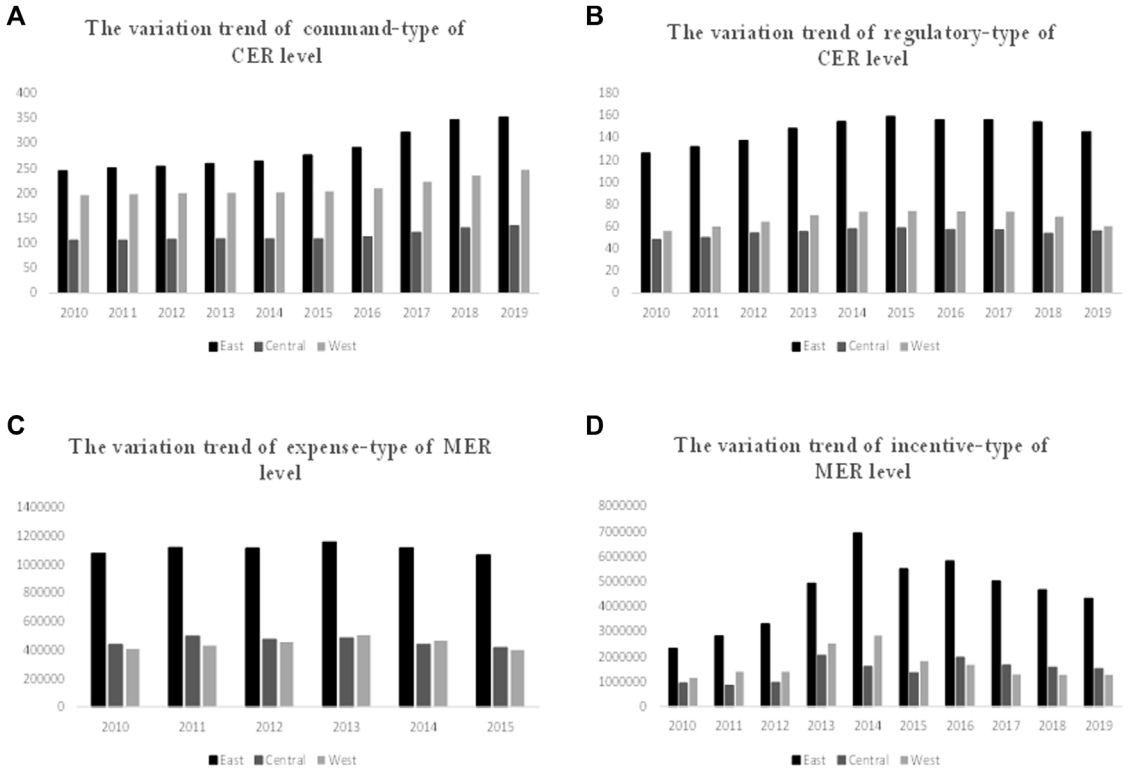

FIGURE 1 | The variation trend of heterogeneous environmental regulation level.

regulatory environmental regulations are one of the most effective ways for government departments to directly grasp the information related to the production and emission of enterprises.

2.1.2 Market-Based Environmental Regulation

MER refers to the use of the explicit economic incentives through fees, investment, or subsidies to promote enterprises to make independent choices between the cost and benefit of pollution discharge, and to determine the level of production technology and the amount of pollution discharge. This has a certain level of flexibility and pertinence. MER can be divided into expense type and the incentive type. Expense-type MER imposes penalties and charges on an enterprise's non-conforming pollutant emission behavior. The Chinese government officially abolished the collection of pollutant discharge fees on enterprises in 2018and stopped data collection of pollutant discharge fees in China's Environmental Statistics Yearbook in 2017. Incentive-type MER refers to the preferential policies, investments, and subsidies that the government carries out on pollutant treatment and clean production of enterprises. **Figure 1C** shows the variation trend and regional differences of pollutant discharge fees collected in China from 2010 to 2015. Among these three regions, the eastern region had the highest pollutant discharge fees, and the central and western regions had almost the same level of environmental regulation. It can also be seen that the amount of pollutant discharge fees collected from enterprises in the eastern region is far more than the sum of the two regions combined, see **Figure 1C**. This phenomenon is related to the level of regional economic development. It also indicates that there are obvious differences in the enforcement of environmental regulation policies in different regions of China. **Table 1** shows the development process of China's incentive environmental regulations from 2006 to 2018. As **Table 1** demonstrates, China's national and local government departments issued a series of incentive environmental regulation policies, including tax incentives, government subsidies, and investment in environmental protection. **Figure 1D** shows the variation trend and regional differences of the incentive environmental regulation denoted by investment amount in pollution control from 2010 to 2019. The level of incentive environmental regulations in the eastern and western regions of China generally showed a trend of first increasing and then declining, and reached a peak in 2014—the peak values were 6,940, 360, 000 yuan and 2,840,591 yuan, respectively. The growth rate reached 197.3 and 147.2% respectively. However, the level of incentive environmental regulation in central region has changed relatively little and the overall level of regulation is constantly improving, with an increase of 60.3%.

TABLE 1 | The development history of incentive environmental regulation in China.

Types of policies	Implementation department	Start time	Objects	Implementation scope
Tax incentives	State Administration of Taxation	2006	Enterprises that use resources to produce	China
Special funds for emission reduction of major pollutants	Ministry of Ecology and Environment, Ministry of Finance	2007	Pollutant enterprise	Major pollution area in China
Waste product disposal subsidy	Ministry of Ecology and Environment	2010	Enterprises that deal with waste electronic products	China
Tax incentives for energy conservation and emission reduction enterprises	State Administration of Taxation	2010	Energy conservation and emission reduction enterprises	China
Special funds for the control of heavy metal pollution	Ministry of Ecology and Environment, Ministry of Finance	2010	Heavy metal pollution enterprises	Heavy metal pollution area in China
Special funds for cleaner production	The State Council, Ministry of Ecology and Environment, Department of Industrial Science and technology	2012	Enterprises that implement cleaner production and its technology popularization	China
Credit support for air pollution prevention and control	The State Council, Ministry of Ecology and Environment, Credit related department	2013	All enterprises	China
Stop collecting sewage charges	The State Council, State Administration of Taxation	2018	All enterprises	China

2.2 The Effect of Heterogeneous Environmental Regulation on Firm Performance

This section will analyze the effect of heterogeneous environmental regulations and their interactions on enterprise performance. It will also propose hypotheses to be tested.

The CER starts with pre-command and post-supervision to control pollution sources to protect the environment, the promulgation and implementation of the normative documents are mandatory. This one-size-fits-all approach does not take the differences in emission reduction capabilities of enterprises into account, and will inevitably lead to increasing production costs and the investment crowding out effect. The CMR is insufficient to encourage technological innovation in environmental protection and it is not conducive to the improvement of enterprise performance. On the one hand, to meet environmental standards and successfully enter the production process, enterprises must purchase appropriate pollution-control equipment or adopt production methods that conform to environmental technical standards. This will result in a sharp increase in production costs, and divert capital away from productive investments and restrict the choice of technologies or inputs in the production process (Dean et al., 2000). On the other hand, once an enterprise's pollution emission generated after production is detected to fail to meet the regulatory standards, then they will be obliged to rectify or even to stop existing invested projects. This will cause direct losses to enterprises (Wang et al., 2019a). Based on this analysis, we propose:

Hypothesis 1: Command-control environmental regulation will inhibit the improvement of enterprise performance.

Compared with command-control tools, market-based tools give enterprises more freedom to choose and they enable enterprises to make optimal choices based on the maximization of economic benefits. Because of its flexibility, MER can act on any process of enterprise's production and operation, thus largely alleviating the ex-ante mechanism of command-based environmental regulation and the ex-post mechanism of regulatory environmental regulation. Expense-based environmental regulation can restrain an enterprise's pollution behavior, and force them to invest in pollution control and technological upgrading. This will improve the enterprise's independent innovation capability (Cheng et al., 2017; Zhang et al., 2018). The innovation capability is mainly reflected in the technological innovation level of the manufacturing enterprise. MER based on investment or subsidies can increase an enterprise's funds for pollution control, and encourage the enterprise to invest in pollution control and clean production technology. The induced improvement of pollution-control capacity and upgrading of production technology will enhance enterprise performance (Shi, 2021). Based on this analysis, we propose:

Hypothesis 2: Market-based environmental regulation can improve an enterprise's performance by improving their technological innovation level.

Environmental regulation includes a wide variety of policy means, different environmental regulation tools have different mechanisms (Guo, 2019), and there is a degree of interaction between the different mechanisms (Zefeng et al., 2018). Under the CER, non-compliant enterprises need to purchase pollution-control equipment, and adjust or even close high-pollution projects to meet specified emission standards. This will increase production costs and lead to a shortage of R&D capital. However, if the government simultaneously implements MER through subsidies, tax incentives, and credit support, the cost loss caused by evading CER will be alleviated. The government's investments and subsidies for cleaner production technology will promote the development and technological level of green industry, reduce the cost and risks of an enterprise's R&D, and improve the profits of R&D. Above all, although CER will increase an enterprise's operating costs for reducing pollution and pollution treatment, the implementation of MER can enhance an enterprise's pollution reducing ability,

increase R&D investment, and improve the level of technological innovation. Consequently, MER in the interactive effect can play a positive role in moderating the disincentive effect of CER. Based on this analysis, we propose:

Hypothesis 3: Market-based environmental regulation will alleviate the disincentive effect of command-control environmental regulation on enterprise performance.

3 EMPIRICAL METHODS AND DATA

3.1 Model Formulation and Empirical Strategies

3.1.1 Model Setting and Variable Selection

Following Cheng (2021), we construct the following empirical models to verify the hypotheses:

$$Performance_{j,t} = \beta_0 + \beta_1 ER_{i,t-1} + \sum \beta X_{controls} + \varepsilon_{it} \quad (1)$$

$$Innovation_{j,t} = \beta_0 + \beta_1 ER_{3,t-1} + \sum \beta X_{controls} + \varepsilon_{it} \quad (2)$$

$$Performance_{j,t} = \beta_0 + \beta_1 ER_{3,t-1} + \beta_2 Innovation_{jt} + \sum \beta X_{controls} + \varepsilon_{it} \quad (3)$$

$$Performance_{j,t} = \alpha_0 + \alpha_1 ER_{1,t-1} + \alpha_2 ER_{3,t-1} + \alpha_3 ER_{1,t-1} \times ER_{3,t-1} + \sum \alpha X_{controls} + \mu_{it} \quad (4)$$

$$Performance_{j,t} = \alpha_0 + \alpha_1 ER_{2,t-1} + \alpha_2 ER_{3,t-1} + \alpha_3 ER_{2,t-1} \times ER_{3,t-1} + \sum \alpha X_{controls} + \mu_{it} \quad (5)$$

Following Wang et al. (2019b) and Zhang et al. (2020), an enterprise's performance is the core explained variable in models (1)–(5), which is measured by financial performance and production performance. We use total return on assets (ROA) and total output level (Output) to denote financial performance and production performance, respectively. Following Zhang (2020) and Shi (2021), innovation represents an enterprise's innovation level, as denoted by R&D investment. Following Shen et al. (2019) and Guo and Yuan (2020), ERi represents the type of environmental regulation, which is the core explanatory variables in the model (1), where ER_1 represents the command type of CER, which is denoted by the number of effective laws and regulations regarding environmental protection in each province. ER_2 refers to regulatory type of CER denoted by the number of staffs of environmental monitoring stations in each province. ER_3 represents incentive-based MER denoted by the ratio of the investment amount of industrial pollution control in the GDP of each province. Learning from Wang et al. (2022), ER3 is the is the moderator in models (4) and (5). As mentioned earlier, the MER is divided into expense type and the incentive type. The expense-based MER is usually measured by sewage discharge fee. However, China's statistical department stopped publishing statistics on sewage discharge fees in 2017 and decided to stop collecting sewage discharge fees in 2018. Therefore, the statistical period of the sewage discharge fee is only available before 2015. Therefore, considering the continuity of the sample data, we abandon the expense-based MER and only investigate the incentive-based MER. The control variables include an *enterprise's capital intensity* (*Capital, ratio of total assets to main business income*), the *type of enterprise ownership* (*Proper, 1 for state-owned enterprises, and 0 otherwise*), *per capital GDP*(*Agdp*), and *industrial development level* (*Industry, ratio of added value of local industrial production to gross regional product*). ε is the random error term. In these models, ***i*** represents each province, ***j*** represents each manufacturing enterprise, and ***t*** represents each year. Descriptive statistics of the variables are shown in **Table 2**.

TABLE 2 | Descriptive statistics of the variables.

Variable	Obs	Mean	Std. Dev	Min	Max
Asset	14,069	6.005	6.362	0.004	188.023
Output	14,069	6.301	24.57	1.433	8.878
ER1	14,069	0.182	0.762	0.16	0.21
ER2	14,069	5.524	4.555	1.02	17.28
ER3	14,069	1.413	0.49	0.067	6.42
Innovation	14,069	1.628	5.705	3.568	159.219
Agdp	14,069	0.24	0.079	0.106	0.585
Capital	14,069	0.346	0.081	0.12	0.518
Proper	14,069	0.336	0.472	0	1
Industry	14,069	0.108	0.51	0.09	0.138
Profit	14,069	0.168	2.93	−0.1	232.002

We use Stata 16.0 to test models (1)–(5) empirically and to verify the research hypotheses.

3.1.2 Empirical Strategies

Model (1) is used to test hypothesis 1, models (2) and (3) are used to test hypothesis 2, and models (4) and (5) are used to test hypothesis 3. In the regression analysis, the following process is carried out. First, considering that it takes a certain time for environmental regulation to affect enterprise performance, we carry out a period of lagging treatment on the level of environmental regulations. This treatment can also weaken the influence of simultaneous causality. Second, we adopt the typical industrial fixed effect and regional fixed effect model.

3.2 Data Sources and Processing

3.2.1 Data Sources

In this study, we select China's A-share listed manufacturing enterprises as the research object. The relevant data of these enterprises comes from the *CASMAR* database, and the data of environmental regulation and related control variables come from the *China Environmental Yearbook*, *China Environmental Statistics Yearbook, Peking University Law Network* data base and *China Statistical Yearbook*. The acquisition procedure of CER data is as follows. First, to obtain the number of local laws and regulations related to environmental protection in each province from 2010 to 2019, we employ *Python* to conduct a keyword search of the websites of the environmental protection departments of each province.

TABLE 3 | Benchmark regression results.

	Asset (1)	Asset (2)	Asset (3)	Output (4)	Output (5)	Output (6)
ER1	−0.204*** (−3.39)	—	—	−0.472***(−2.78)	—	—
ER2	—	−0.021*** (−5.30)	—	—	−0.492*** (−4.45)	—
ER3	—	—	1.248** (2.45)	—	—	0.616*** (4.28)
Controls	YES	YES	YES	YES	YES	YES
Sample Size	14,069	14,069	14,069	14,069	14,069	14,069
Fixed Effect	YES	YES	YES	YES	YES	YES

*Note: ***p < 0.01, **p < 0.05, and *p < 0.1. The fixed effect refers to the industrial and regional fixed effect.*

TABLE 4 | Regression results of the mediating effect model.

	Innovation (1)	Asset (2)	Output (3)
ER3	4.044*** (6.25)	0.061*** (7.59)	0.162 (1.09)
Innovation	—	0.006*** (1.71)	0.132*** (55.48)
Controls	YES	YES	YES
Sample Size	14,069	14,069	14,069
Fixed Effect	YES	YES	YES

*Note: ***p < 0.01, **p < 0.05, and *p < 0.1. The fixed effect refers to the industrial and regional fixed effect.*

Second, we add the retrieved data to the number of relevant laws and regulations issued by the State Council of China from the Database of Peking University Law Network to obtain the level of command-based CMR in each province from 2010 to 2019.

3.2.2 Data Processing

We process the data as follows. First, we exclude ST, ST*, PT enterprises. Second, we keep manufacturing enterprises. Third, according to the same province name, the data of environmental regulation intensity at the provincial level were matched with the province where listed manufacturing enterprises were located. Finally, the data were curtailed by 1% to obtain the "enterprise-year" panel data from 2010 to 2019, containing 14,069 samples.

4 EMPIRICAL RESULTS AND ANALYSIS

4.1 The Empirical Test of Hypotheses 1 and 2

This study selects the fixed panel model (1) to verify the relationship between heterogeneous environmental regulation and manufacturing enterprise performance. The investigation about the impact of heterogeneous environmental regulation on the manufacturing enterprises' performance is part of the academic literature in environmental economics and business management. The regression results are shown in **Table 3**.

Columns (1)–(3) and (4)–(6) of **Table 3** empirically test the relationship between "heterogeneous environmental regulation-financial performance of manufacturing enterprises" and "heterogeneous environmental regulation-production performance of manufacturing enterprises," respectively. The model in columns (1)–(6) controls the fixed effect of "industry-region". The results in columns (1) and (2) show that both command type of CER and regulatory type of CER have a significantly negative impact on the financial performance and production performance of manufacturing enterprises, and both pass the statistical significance test of 1%. This indicates that the implementation of CER is not conducive to the improvement of financial performance and production performance of manufacturing enterprises. Thus, hypothesis 1 is verified.

The results in columns (3) show that the incentive-based MER has a positive effect on the financial performance and production performance of manufacturing enterprises, and passes the statistical significance test of 5 and 1% respectively. To examine the mechanism by which incentive-based MER affects enterprises performance, we construct the mediating effect models (2) and (3), and select *innovation* as the intermediary factor for testing (Sheng and Liu, 2021). The regression results in **Table 4** show that the regression coefficient of ER_3 on enterprise technological innovation is significantly positive. This means that incentive-based MER promotes the technological innovation of manufacturing enterprises. Furthermore, the technological innovation has a significant effect on the financial performance and production performance of enterprises. This indicates that incentive-based MER can improve enterprise performance by boosting the level of an enterprise's technological innovation. Thus, hypothesis 2 is verified.

4.2 The Empirical Test of Hypothesis 3

Considering the interaction between heterogeneous environmental regulations, we construct the moderating models (4) and (5) to test whether or not implementation of MER alleviates the disincentive effect of CER on the performance of manufacturing enterprises. As the regression results in **Table 5** show, the coefficients of interactive items are significantly positive, and the significance levels of both the $ER_1$and ER_2 coefficients change compared with the corresponding results in **Table 3**. This means that the implementation of MER reduces the negative effect of CER on enterprise performance. Thus, hypothesis 3 is verified.

TABLE 5 | Test of the interaction effects of heterogeneous environmental regulations.

	Asset (1)	Asset (2)	Output (3)	Output (4)
ER1	−0.179 (−1.19)	—	−0.296 (−0.46)	—
ER2	—	−0.022** (−2.04)	—	−0.178 (−
ER3	0.762*** (4.23)	0.21* (1.61)	0.123 (1.05)	0.762*** (4.23)
ER1x ER3	0.542*** (3.21)	—	0.561*** (3.35)	—
ER2x ER3	—	0.068 (0.56)	—	0.541*** (3.21)
Controls	YES	YES	YES	YES
SampleSize	14,069	14,069	14,069	14,069
Fixed Effect	YES	YES	YES	YES

*Note: ***p < 0.01, **p < 0.05, and *p < 0.1. The fixed effect refers to the industrial and regional fixed effect.*

TABLE 6 | Robustness test.

	Profit (1)	Profit (2)	Profit (3)	Asset (4)	Asset (5)	Asset (6)
ER1	−3.691* (−0.53)	—	—	−0.036*** (−3.47)	—	—
ER2	—	−4.971* (−1.91)	—	—	−0.004*** (−6.24)	—
ER3	—	—	0.472* (1.03)	—	—	3.156*** (3.70)
Controls	YES	YES	YES	YES	YES	YES
Sample Size	14,069	14,069	14,069	14,069	14,069	14,069
Fixed Effect	YES	YES	YES	YES	YES	YES

*Note: ***p < 0.01, **p < 0.05, and *p < 0.1. The fixed effect refers to the industrial and regional fixed effect.*

4.3 The Robustness Check

We employ two ways to verify the robustness of the empirical results, namely substitution of core independent variables and 50% quantile regression. The results are shown in **Table 6**.

Columns (1)–(3) of **Table 6** replace the core independent variable with the *net profit rate* of the manufacturing enterprises for the robustness check. Columns (4)–(6) are the results of the *50% quantile regression*. It can be seen from the results in the **Table 6** that there is no substantial change in the coefficients. Therefore, the results of this study are robust.

5 CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusion

Considering the heterogeneity of environmental regulations and the effect of the interaction between heterogeneous environmental regulations on enterprise performance, this study selects panel data of Chinese manufacturing enterprises from 2010 to 2019 to conduct an empirical study. The conclusions are as follows. First, there are significant differences in the impact of heterogeneous environmental regulation on the manufacturing enterprise's performance: both command type and regulatory type of CER have a negative impact on the manufacturing enterprise's performance, while MER significantly promotes the manufacturing enterprise's performance. Second, the influence mechanism of the MER-promoting hypothesis is verified from the micro-perspective. MER can promote an improvement in the performance of manufacturing enterprises by improving the level of enterprise technological innovation and enterprise technological innovation plays a partial intermediary role. Finally, according to the moderating effect model, the implementation of MER alleviates the disincentive effect of CER on the performance of manufacturing enterprises.

5.2 Discussion

This study uses empirical research methods to analyze the impact of heterogeneous environmental regulations on the performance of China's manufacturing enterprises, which reveals the heterogeneity of PH from the micro-perspective and shows that different regulations have different degrees of impact on the enterprises. In particular, the main research contribution of this article is to explore the impact of the interaction between MER and CMR on the performance of manufacturing enterprises. The application of different environmental regulations will have a regulatory effect. We find that MER will significantly alleviate CER's inhibitory effect on the performance of manufacturing enterprises. This study also fills in the research gap in the promotion mechanism of MER on the performance of manufacturing enterprises by using a micro-empirical method. However, considering the continuity of research data and rigorous research, this article has not incorporated the expense-based MER into the research system. This study only focuses on the financial performance and production performance of manufacturing enterprises. In future research, we aim to study the impact of heterogeneous environmental regulation on high-polluting enterprises and high-tech enterprises, and will then expand the research content. In addition, we only explored the role of technological innovation as an intermediary factor. Future research can continue to explore other influence paths between environmental regulation and an enterprise's performance. In addition, the empirical model can also be applied in testing the effects of environmental regulation on

economic development, ecological protection, and human capital mobility.

5.3 Policy Implications

China is currently moving from extensive to intensive development. Consequently, the government will formulate a series of environmental protection regulations to prevent production pollution effectively. Therefore, we include here some policy implications of our research. First, through empirical regression analysis of the data, it is found that different types of environmental regulations have significantly different effects on an enterprise's performance. Therefore, the local government should formulate environmental regulation tools in line with the regional economic development according to the status of the regional ecological environment, which will achieve a win-win situation between environmental protection and high-quality economic development. Second, the mediating role of technological innovation in environmental regulation and enterprise performance has been verified. Therefore, the government should strongly support enterprises who wish to improve their own production technology level and advocate innovative production. Finally, when manufacturing enterprises face heterogeneous environmental regulation, although MER could alleviate CER's inhibitory effect on the performance of manufacturing enterprises, the production and operation of manufacturing enterprises must comply with environmental regulation standards, and must reasonably avoid government regulation and punishment to reduce capital losses because this will help companies to achieve a high level of performance development.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article and supplementary material. Further inquiries can be directed to the corresponding authors.

AUTHOR CONTRIBUTIONS

WC is responsible for article revision and editing, SC is responsible for theoretical combing and article writing, and TW is responsible for data collection and proofreading.

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