frontiers | Frontiers in Environmental Science

TYPE Original Research
PUBLISHED 04 January 2023
DOI 10.3389/fenvs.2022.1070143

OPEN ACCESS

EDITED BY
Rui Xue,
Macquarie University, Australia

REVIEWED BY
Yunjing Wang,
Shandong University of Finance and Economics, China
Longguang Yu,
Shandong University of Finance and Economics, China

*CORRESPONDENCE
Chaoya Xu,
1009289845@qq.com
Jiangna Li,
498451839@qq.com

SPECIALTY SECTION
This article was submitted to Environmental Economics and Management, a section of the journal Frontiers in Environmental Science

RECEIVED 14 October 2022
ACCEPTED 08 December 2022
PUBLISHED 04 January 2023

CITATION
Zhong T, Xu C, Liu H and Li J (2023), Can the National Specially Monitored Firms program improve corporate environmental performance?—Empirical evidence from China. *Front. Environ. Sci.* 10:1070143. doi: 10.3389/fenvs.2022.1070143

Can the National Specially Monitored Firms program improve corporate environmental performance?—Empirical evidence from China

Tingyong Zhong[1], Chaoya Xu[2]*, Hui Liu[1] and Jiangna Li[3]*

[1]School of Accounting, Chongqing Technology and Business University, Chongqing, China, [2]School of Economics and Management, Southwest University, Chongqing, China, [3]School of Wealth Management, Chongqing University of Finance and Economics, Chongqing, China

As an important measure of reform of the central environmental supervision, the National Specially Monitored Firms program has a significant impact on enterprise pollution control. However, there are few studies that have systematically studied the mechanism of this system on enterprise environmental performance. Based on the quasi natural experiment of the National Specially Monitored Firms program, this article uses the emission data of industrial enterprises from 2001 to 2009 to investigate the impact of the central environmental supervision on on corporate environmental performance by using the DID method. It is found that the National Specially Monitored Firms program has significantly improved the corporate environmental performance of the monitored enterprises. Heterogeneity analysis finds that when compared with enterprises with a higher degree of financing constraints, export enterprises, and enterprises with a lower level of economic development in the region, the implementation of the National Specially Monitored Firms program has a more significant effect on improving the environmental performance of enterprises with a lower degree of financing constraints, domestic enterprises, and enterprises with a higher level of economic development in the region. The mechanism test shows that improving the enterprise environmental protection equipment investment is not the only intermediary mechanism for the National Specially Monitored Firms program to improve corporate environmental performance. The conclusions of this article are not only conducive in optimizing the environmental governance methods but also inspirational for monitoring practices in other fields.

KEYWORDS

National Specially Monitored Firms program, corporate environmental performance, financing constraints, export enterprises, level of economic development

1 Introduction

In recent years, with the rapid development of the economy, problems such as environmental pollution, ecological damage, and excessive consumption of resources have become very serious (Su and An, 2018; Tao et al., 2022) will all limit the sustainable development of the world economy (Muller et al., 2011; Gupta et al., 2019). To this end, governments are actively building a sound environmental legal system. Although remarkable results have been achieved, some pollution problems are still continuing. In particular, as an important participant in the market economy and a major emitter of pollutants, enterprises are pursuing economic goals. In the process, the environmental problems highlighted above are becoming increasingly serious. For example, the "A-share ESG rating analysis report 2020" shows that from June 2012 to June 2020, there were 19,770 ESG risk events in China, which included 8,447 environmental risk events, accounting for 43%, ranking first. It can be seen that enterprises have become heavy disaster areas of current environmental pollution.

The existing research on the driving factors of corporate environmental performance mainly involves the environmental system, market competition, and internal governance (Tran and Pham, 2020; Chen et al., 2021; Zhou et al., 2021; Wang et al., 2022), where environmental regimes are a core driver of corporate environmental performance. At present, the number of environmental laws, regulations, and normative documents in China has been the same as that in developed countries, but the enforcement of the local environmental law is poor (Lu, 2022). This is because, as a formal system, the operation process of the policy includes two links: formulation and implementation. The governance effect of the final policy depends 90% on the implementation link (Shen and Zhou, 2017). Policy implementation is the key factor in determining whether the policy is effective. This is especially true for environmental policies. Especially under China's current environmental decentralization system, the implementation process of environmental policies is formed by a set of complex principal–agent chains, and there must be different principal–agent problems between the different levels (Yu, 2016). First, at the level of the central government and local government, the central government is the principal and the local government is the agent. The relationship between the two is "decision-making and implementation," and the target difference, information gap, and limited regulatory capacity between the two will lead to poor environmental law enforcement by the local governments (Khanna and Anton, 2002; Zhang et al., 2019), resulting in the principal–agent problem. Second, at the level of the local governments and enterprises, the local governments are principals and enterprises are agents, and the relationship between them is "to regulate and be regulated, to support and be supported"; however, information asymmetry between the government and enterprises, high difficulty of environmental evaluation, and limited monitoring and inspection capabilities of the local regulators (Van Rooij, 2006) all lead enterprises to send false environmental information to government departments, resulting in adverse selection problems. In addition, local governments have greater law enforcement discretion over China's administrative, economic, and social resources, creating rent-seeking opportunities for enterprises (Du and Mickiewicz, 2016), especially in resource-poor areas where moral hazards are more likely to occur. Third, at the level of people and government, people and enterprises, people are the principal and the government and enterprises are the agents. The relationship between them is "supervision and supervised." When compared with the government and enterprises, people lack the necessary information sources, and the low threshold conditions in obtaining information lead to the inability of implementing the environmental policy chain in forming effective policy closed loops in the feedback links. If the principal–agent problem at different levels cannot be solved comprehensively, the effect of the environmental policy is greatly reduced.

To strengthen the supervision of implementation of the environmental policies, the central government has introduced a series of environmental supervision measures, such as auditing the departure of natural resource assets of leading cadres, environmental supervision, environmental interviews, and government environmental audits (Earnhart et al., 2020; Wu et al., 2020; Cao et al., 2021; Wang et al., 2021; Jiang et al., 2022). In 2007, China fully established the National Specially Monitored Firms program (hereinafter referred to as the "NSMF program"), which aims to reform China's traditional environmental decentralization system (Zhang et al., 2018). Different from the other means of environmental supervision, the NSMF program has unique advantages, mainly in the following: first, the "supervise local governments" feature deters local governments' environmental law enforcement efforts. Second, the characteristics of "regulated enterprises" regulate the illegal discharge of enterprises. Third, the threshold of public participation is lowered, and the supervision of local governments and enterprises is strengthened. It can be seen that the NSMF program aims at the complex principal–agent chain in the process of environmental governance and constructs an environmental governance system led by the government, with enterprises as the main body and social organizations and the public participating together, which effectively makes up for the shortcomings of other environmental regulatory measures. Scholars have conducted much discussion on the NSMF program, but mainly, there is a lack of empirical research around the policy itself, especially at the microlevel. However, how microenterprises respond to the policy is very important to test the environmental governance effect of the NSMF program. Therefore, this article proposes the following questions: can the NSMF program effectively improve corporate environmental

performance? Will it effectively show the heterogeneity of enterprises?

When compared with existing literature, we have made several contributions to the literature mainly in three aspects. First, this article expands the research paradigm of the NSMF program. The literature mainly discusses the policy requirements, technology application, and improvement methods of state-controlled projects from the theoretical level. Few scholars use empirical data to study the impact of the NSMF program on microenterprises, which makes the operation and implementation of the NSMF program lack practical microlevel theoretical support and guidance. This article uses empirical methods to explore the impact of the NSMF program on corporate environmental performance and expands the research paradigm of the NSMF program from normative to empirical, which is a good supplement to this research field. Second, this article enriches the influencing factors of corporate environmental performance. At present, a few scholars have discussed the impact of environmental policies on corporate environmental performance. However, on the one hand, the literature only examines the impact of environmental policies on corporate environmental behavior from a single perspective of "supervise local governments" environmental policies or "regulated enterprises" environmental policies, which inevitably separate the entire principal–agent chain in the process of environmental governance and cannot accurately evaluate the implementation effect of environmental policies. On the other hand, when discussing the micro-effects of environmental policies, the literature has no comprehensively analyzed the principal–agent problems between different levels and lacks a complete and systematic analysis framework. This article starts from an environmental policy with the characteristics of both "supervise local governments" and "regulated enterprises," integrates various principal–agent problems in the implementation chain of the environmental policy, examines the impact of the NSMF program on corporate environmental performance, and enriches the literature in this field. Third, this article identifies the mechanism of the NSMF program on corporate environmental performance. The implementation effect of the environmental policies is usually related to the implementation efficiency of the local governments. With the frequent occurrence of corporate pollution problems in China, exploring the impact of environmental law enforcement supervision on corporate environmental performance has practical significance. This article not only discusses the impact mechanism of the NSMF program on corporate environmental performance but also conducts in-depth research based on different situations, which provides directional guidance and policy reference for better playing the role of the NSMF program in environmental governance.

The rest of this article is organized as follows: Section 2 reviews previous relevant studies, Section 3 proposes research assumptions, Section 4 describes the data and variables, Section 5 reports the empirical results, and Section 6 summarizes the findings and provides policy implications.

2 Literature review

2.1 National Specially Monitored Firms program

As an important part of the central environmental supervision, the NSMF program is an environmental regulation that introduces modern means for environmental governance. Specifically, first, the NSMF program determines whether it is included in the national control list according to the pollution emissions of the enterprise in the past two years; subsequently, enterprises included in the national control list must install and maintain automatic monitoring equipment for pollution sources according to regulations and transmit real-time emission data to the national monitoring network; and finally, the monitoring center supervises and inspects the data on a monthly basis and requires at least one on-site inspection per month to ensure the normal operation of the pollution source automatic monitoring equipment and accuracy of the data. The existing research on the NSMF program is still relatively scarce, mainly focusing on the following four aspects. First, there is research on the program itself. For example, Yuan and Cao (2017) analyzed the existing problems of the NSMF program and proposed corresponding countermeasures and suggestions. Second, there is research on the application of project monitoring data. For example, Gao et al. (2020) analyzed the problems in the use of monitoring data for sewage treatment. Third, there is research on the key monitoring enterprises of the NSMF program. For example, Yin et al. (2018) proposed the "disciplinary cage" hypothesis by taking the key monitoring enterprises of the NSMF program, while Yin et al. (2020) took the key monitoring enterprises of the NSMF program as the research object and found that the replacement of municipal party secretaries negatively affected enterprise innovation; fourth, they researched the implementation consequences of the NSMF program. For example, Fang et al. (2020) used empirical evidence from the NSMF program and enterprise-level data from 2001 to 2009 to study the impact of environmental regulation on enterprise innovation. They found that the implementation of the NSMF program has increased the innovation of monitored enterprises and verified the weak Porter hypothesis theory.

2.2 Corporate environmental performance

Enterprises are important "consumers" of natural resources and major emitters of pollutants, and the improvement in their

environmental performance is the micro-foundation for achieving environmental governance objectives. In fact, corporate environmental performance has immeasurable value for the long-term development of enterprises and high-quality development of the national economy. For enterprises, the improvement in corporate environmental performance can promote technological innovation, improve production efficiency, enhance social reputation, attract environmentally sensitive customers, and increase corporate competitive advantages (Hart and Ahuja, 1996; Konar and Cohen, 2001; Orlitzky et al., 2003) to promote the sustainable development of enterprises. Therefore, how to improve corporate environmental performance has become an important issue for the government, society, and enterprises.

At present, a large number of scholars have explored the influencing factors of corporate environmental performance. First, at the microlevel, some scholars believe that executive compensation (Zou et al., 2015), executive characteristics (Francoeur et al., 2020; Tran and Pham, 2020), and internal carbon pricing (Zhu et al., 2022) will have an impact on corporate environmental performance. Second, at the meso level, they mainly examine the impact of community pressure (Zhou et al., 2021), social trust (Chen et al., 2021), and stock market value (Endo, 2019) on corporate environmental performance. Third, at the macro-level, this article is directly related to the environmental policy and corporate environmental performance literature. For example, Earnhart et al. (2020) empirically analyzed the impact of law enforcement fairness on corporate environmental performance, indicating that unfair law enforcement methods will enable companies to show better environmental performance levels. Jiang et al. (2022) investigated the impact of the natural resource asset departure audit policy on corporate environmental performance and concluded that the departure audit significantly promoted the improvement of corporate environmental performance. Cao et al. (2021) examined the impact of government audits on corporate environmental performance, taking the vertical management reform initiative of government audit institutions piloted in China in 2015 as an example, and believed that government audits can improve corporate environmental performance. Wang et al. (2022) investigated the impact of central environmental protection inspectors on corporate environmental investment and concluded that central environmental protection inspectors effectively increased the level of corporate environmental investment.

3 Hypothesis development

3.1 National Specially Monitored Firms program and corporate environmental performance

Since 2006, China has gradually shifted the main body of responsibility for pollution control and environmental protection supervision from enterprises to the local government. However, while the "supervise local government" environmental policy has achieved certain results, it has also caused a series of problems worthy of attention. For example, some local governments use environmental data manipulation to modify environmental assessment indicators (Chen et al., 2012). The NSMF program introduces informatization and modernization for environmental governance, optimizes the information communication path between various levels in the environmental decentralization system, and improves the existing environmental law enforcement problems in China. This article believes that the NSMF program mainly affects the environmental performance of enterprises from the following three aspects. First, the NSMF program can alleviate the principal–agent problem between the central government and local governments and improve corporate environmental performance by deterring the local governments' environmental enforcement efforts. Under a decentralized system with Chinese characteristics, the vast majority of law enforcement power is delegated to local governments (Li et al., 2020), and the "GDP tournament" makes local governments often acquiesce with companies "abandoning the environment and protecting the economy" when acting as agents, leading to the failure of the local government's control of pollution (Sun et al., 2021). The NSMF program introduces advanced technologies such as informatization and automation into environmental law enforcement and has the advantages of continuous online, all-day operation, and nationwide networking such that the central government can directly collect more reliable and accurate information on enterprise pollution emissions, enable local governments to accept law enforcement supervision in a more transparent environment, and form a deterrent to local governments. At this point, the local government passes the supervision pressure from the central government on environmental protection law enforcement to the local enterprises and strengthens environmental supervision or assessment (Jiang et al., 2022). Under the pressure of environmental protection, enterprises must take measures such as factory shutdown, production reduction, and green innovation to reduce emissions (Zhao et al., 2015; Hashmi and Alam, 2019; Fang et al., 2020; Yang et al., 2020) to improve environmental performance.

Second, the NSMF program can alleviate the principal–agent problem between local governments and enterprises and regulate the illegal discharge of enterprises by improving the environmental law enforcement level of local governments. Under the traditional environmental supervision mode, it is difficult for local governments to grasp the real pollution level of enterprises, and it is more difficult to grasp the evidence of illegal pollution discharge by enterprises (Zhang et al., 2018), which often leads to inefficient environmental governance of "one size fits all." The NSMF program requires a comprehensive inspection of the standardization of monitoring ports, the

construction of monitoring stations, and the installation of equipment for state-controlled enterprises in the jurisdiction. For those that do not meet the requirements, rectification plans should be listed one by one, and those with serious circumstances should be ordered to withdraw from the market. The installation of automatic monitoring equipment for pollution sources is the installation of a pair of "electronic eyes" on enterprises to implement real-time and continuous remote monitoring of the concentration and discharge of pollutants by enterprises (Fang et al., 2020), which effectively reduces the information asymmetry between local governments and enterprises and deters enterprises from discharging pollutants. At this time, once a company's illegal discharge behavior is found, it will face administrative penalties and damage to its corporate reputation (Rick et al., 2021; He et al., 2022) or directly affect its eligibility to enjoy relevant preferential policies (Johan and Lans, 2020; Lu, 2022). To prevent this risk, companies have the incentive to improve their environmental performance and achieve their own sustainable development.

Third, the NSMF program can alleviate the principal–agent problem between people and government and between people and enterprises and amplify the deterrent effect of the environmental policy by increasing the participation of the public. On the one hand, the government's vigorous publicity of the NSMF program and environmental protection has sent a signal to the society that the government attaches importance to environmental protection and has raised the public's awareness of environmental protection. At the same time, measures such as the real-time disclosure of monitoring information and user satisfaction surveys have lowered the threshold for public participation, activated social supervision networks, and increased public willingness to participate in environmental governance. Increased public environmental awareness and willingness to participate amplifies the deterrent effect on local governments and businesses, which is conducive for the improvement of corporate environmental performance (Kostka and Mol, 2013; Van Rooij, 2016). On the other hand, after an enterprise is included in the national control list, it faces more attention from the market and investors. When the enterprise's environmental performance is poor, it loses favor of the market and investors. As a "rational economic man," to maximize profits, enterprises have to make corresponding adaptive behavioral responses under the stimulation of environmental policies and market preferences, take the initiative to reconfigure resources, adopt green innovation and other ways to improve their environmental performance, and improve their market competitiveness. In summary, this article proposes the following hypotheses:

H1. With other conditions unchanged, the NSMF program can significantly improve corporate environmental performance.

3.2 Impact of financing constraints

The heterogeneity of enterprises' own resources lead to differences in impact of the NSMF program on corporate environmental performance (Fang et al., 2020). From the perspective of cost–benefit theory, the impact of the NSMF program on corporate environmental performance is related to corporate financing constraints. Measures for the Administration of Automatic Monitoring of Pollution Sources (2005) stipulate that the construction, operation, and maintenance of automatic monitoring equipment are self-financed by polluters, and the expenditure of these non-productive activities often crowds out potential investment by companies in expanding production. On the one hand, when the NSMF program is implemented, enterprises with a high degree of financing constraints resist the development of the relevant work of the pollution source monitoring system and in the face of punishment for excessive sewage discharge or the abnormal operation of equipment, there is the idea of "two penalties take the lightest," that is, deliberately letting equipment failure or even man-made destruction of equipment, rendering the pollution source monitoring instruments useless. On the other hand, the higher the degree of financing constraints of sewage enterprises, the less motivated they become to take the initiative to improve their environmental performance through technological innovation (Tian et al., 2022; Aghion et al., 2016). Therefore, financing constraints may weaken the effect of the NSMF program on corporate environmental performance. In summary, this article proposes the following assumptions:

H2. With other conditions unchanged, compared with enterprises with a higher degree of financing constraints, the NSMF program has a more significant effect on the environmental performance of enterprises with a lower degree of financing constraints.

3.3 Impact of international trade

In the context of globalization, trade openness is an important factor affecting the environment. Therefore, the relationship between the NSMF program and corporate environmental performance will inevitably be affected by international trade. On the one hand, when compared with domestic enterprises, export enterprises face more stringent environmental requirements. In the international market, the requirements for environmental protection in various countries are constantly increasing (Peng et al., 2020), especially in developed countries with higher economic and technological levels, which generally implement higher environmental protection technical standards, such as the "EPA mark" of the United States, the "EV system" of the European Union, the "ECP" of Canada, and the "ecological mark" of Austria, which

makes the export enterprises themselves face more stringent environmental requirements. To meet the environmental standards of the developed countries, export enterprises must reduce pollution to obtain environmental certification of developed countries (Bloom et al., 2013; De Loecker and Goldberg, 2014). On the other hand, when compared with domestic enterprises, international trade has strengthened the technological exchanges between export enterprises and developed countries. Export enterprises can participate in the global export market and have access to the most advanced manufacturing, technology R&D, and management methods of developed countries (Roy and Yasar, 2015). Correspondingly, in the process of expanding and operating export markets in developed countries, export enterprises have the opportunity to obtain more green production technologies to improve their own environmental performance (Zhou et al., 2018). Torres (1999) also pointed out that through free trade, residents' income has increased significantly and more resources and technology can be used to improve the environment. Regardless of whether it is included in the national control list or not, the environmental performance of export enterprises will be better than that of domestic enterprises, so the improvement in the environmental performance of enterprises by the NSMF program is more obvious in domestic enterprises. In summary, this article proposes the following assumptions:

H3. With other conditions unchanged, when compared with export enterprises, the NSMF program has a more significant impact on the environmental performance of domestic enterprises.

3.4 Impact of the economic development level

The level of economic development in the region where the enterprise is located is also an important factor in testing the impact of the NSMF program on corporate environmental performance. The operation of the NSMF program project shows that the central government attaches great importance to local environmental governance, and environmental protection has become one of the important assessment indicators for the promotion mechanism of local officials. However, according to the theory of multi-objective assessment, when the assessed aspect evaluates multiple objectives, it gives priority to achieving goals that are less difficult and more effective (Holmstrom and Milgrom, 1991). When compared with environmental protection goals, the economic growth goals have clearer measurements and more efficient ways of achieving them. Therefore, when the downward pressure on the regional economy increases, the local governments may choose to relax environmental regulations in exchange for economic growth, thereby weakening the motivation of corporate environmental governance. Conversely, when the level of regional economic development is high, the opportunity cost for local governments to pursue environmental protection goals is small (Tang, 2015). Under the pressure of the NSMF program, local governments can increase their law enforcement efforts and strive to achieve the dual goals of environmental protection and economic growth, thereby enhancing the motivation for corporate pollution control and improving the environmental performance of enterprises. In summary, this article proposes the following assumptions:

H4. With other conditions unchanged, compared with regions with lower levels of economic development, the NSMF program has a more significant effect on corporate environmental performance in regions with higher levels of economic development.

4 Research design

4.1 Sample and data collection

This article mainly uses two types of micro data. One is the enterprise pollution emission data, which is from the China Industrial Enterprise Pollution Database from 1998 to 2010. The database is considered to be the most comprehensive and reliable enterprise-level pollution emission data in China (Zhang et al., 2018). Second, other data at the enterprise level are from the China Industrial Enterprise Database from 1998 to 2013. Referring to the practice of Brandt et al. (2012) and Su (2020), we matched the data of the two databases, eliminating the missing data of enterprise codes, and finally selected the data from 2001 to 2009 as the research sample. At the same time, this article sets the year of policy implementation as 2007 because although the NSMF program's list is dynamically adjusted every year in principle, the list does not change until 2010 when compared with 2007. Therefore, this article sets the treatment group as the enterprises listed on the NSMF program's list in 2007. After eliminating the missing values of the main variables, 10,006 observations were finally obtained. In addition, to control the impact of extreme values, this article winsorizes all continuous variables at the 1% and 99% levels, and all operations are completed using Stata 16.0.

4.2 Model design

To verify H_1, the following difference-in-differences model was built:

$$EP_{it}\,(CEP_{it}) = \alpha + \beta_1 Treat_i * Post_t + \beta_2 Controls_i + \lambda + \mu + Year * Province + Industry + \varepsilon_{it}. \quad (1)$$

This article measures corporate environmental performance from the two aspects of emission reduction and energy savings; EP_{it} represents the comprehensive emission intensity of

enterprise i in year t, CEP_{it} represents the unit energy consumption of enterprise i in year t, and $Treat_i$ is a grouping dummy variable—if the enterprise is included in the national control list, it is assigned to 1; if otherwise, it is assigned 0. $Post_t$ is a time dummy variable—if it is in the year of policy implementation in 2007 or after, the value assigned is 1; if otherwise, it is 0. X_i is the control variable, λ is the time fixed effect, μ is the individual fixed effect, and ε_{it} is the random error term. This article focuses on the coefficient β_1 of the cross-term between $Treat_i$ and $Post_t$, which reflects the net impact of the NSMF program on corporate environmental performance. When β_1 is significantly negative, it means that the NSMF program inhibits the comprehensive emission intensity of enterprises or reduces the unit energy consumption of enterprises, that is, it improves the environmental performance of monitored enterprises. In addition, H2, H3, and H4 are tested by grouping.

4.3 Measurement of variables

4.3.1 Dependent variable

The explained variables of this article are of corporate environmental performance (EP_{it} and CEP_{it}). The literature on the measurement of environmental performance can be roughly divided into pollution emission methods, evaluation system methods, ecological benefit methods, environmental capital expenditure methods, etc. Among them, the pollution emission method can be more intuitive and accurate. To measure the environmental performance of enterprises, this article refers to the practice of Su (2020) and selects industrial wastewater, chemical oxygen demand, industrial waste gas, sulfur dioxide, and soot and dust to construct a comprehensive index of enterprise pollution emission intensity and measures the environmental performance of enterprises from the perspective of "emission reduction." The enterprise comprehensive emission intensity specific calculation formula is as follows:

$$EP_{it} = \frac{1}{n}\sum_{\omega=1}^{n}(W_{\omega it} \times UP_{\omega it}), \quad (2)$$

where EP_{it} is the enterprise comprehensive pollution intensity, ω denotes the type of pollutant, n denotes the number of pollutant species, w is the adjustment coefficient, represented by the ratio of the emission intensity of various pollutants of the enterprise to the national average, and UP is the dimensionless emission intensity of various pollutants from enterprises after Z-score standardization.

At the same time, to comprehensively measure the environmental performance of corporations, this article also selects the unit energy consumption of enterprises from the perspective of "energy saving." Since the proportion of coal in China's energy consumption is basically maintained at 70%, and China's coal resources and price advantages make the coal-based energy pattern unchangeable for a long time, the physical quantity of coal can better reflect the energy input of Chinese industrial enterprises. Therefore, this article uses coal consumption to calculate the unit energy consumption (CEP_{it}) of enterprises as another measure of corporate environmental performance.

4.3.2 Independent variable

The independent variable of this article is Treat*Post. Treat is a grouping dummy variable, indicating whether the enterprise is included in the NSMF program's list. If the enterprise is included in the NSMF program's list, it is defined as the treatment group, and Treat is assigned the value 1, if otherwise, it is assigned the value 0. Post is a time dummy variable that represents the year in which the NSMF program was run. If it is in 2007 and later, Post is assigned a value of 1; if otherwise, it is assigned 0.

4.3.3 Regulated variables

1) Financing constraints (FC): this article uses the SA index method to calculate the financing constraints of enterprises and divides the samples into a higher financing constraint group and a lower financing constraint group according to the median of the SA index. If it is less than the median, it is the lower financing constraint group, and the FC assignment is 1. If it is greater than the median, it is the higher financing constraint group, and the FC assignment is 0. The SA index is calculated as follows:

$$SA = 0.737*Size + 0.043*Size^2 - 0.04*Age. \quad (3)$$

2) Export/domestic (IM): according to the export volume of the enterprise, whether the enterprise participates in international trade is judged. If the export volume of the enterprise is greater than 0, it indicates that the enterprise is an export enterprise, and the IM assignment is 1; if otherwise, it is 0.
3) Regional economic development level (PGDP): in this paper, the *per capita* GDP at the city level is used to measure the economic development level of each region. Based on the median, the samples are divided into groups with higher economic development levels and lower economic development levels. If it is greater than the median, it indicates that the economic development level of the region is higher, and the PGDP is assigned 1; if otherwise, it is 0.

4.3.4 Control variables

This article selects company size (Size), nature of ownership (Soe), company age (Age), financial leverage (Lev), profitability (Roa), fresh water in industrial water (Water), number of

TABLE 1 Definition of primary variables.

Variable type	Variable name	Variable symbol	Variable declaration
Dependent variable	Comprehensive discharge intensity	*EP*	$EP_{it} = \frac{1}{n}\sum_{\omega=1}^{n}(W_{\omega it} \times UP_{\omega it})$
	Unit energy consumption	*CEP*	Total coal consumption tons/total industrial output value
Independent variable	Group virtual variable	*Treat*	If the enterprise is included in the national control list, the value is 1; otherwise, it is 0
	Time virtual variable	*Post*	In 2007 or later, the value is 1; otherwise, the value is 0
Regulated variables	Financing constraints	*FC*	If it is lower than the median of SA index, it is assigned a value of 1; otherwise, it is 0
	Export/domestic enterprises	*IM*	If the export amount of the enterprise is greater than 0, the value is 1; otherwise, it is 0
	Level of regional economic development	*PGDP*	GDP *per capita* of each city/10,000. If it is higher than the median, the assigned value is 1; otherwise, it is 0
Control variables	Enterprise size	*Size*	Natural log of total assets in millions at the year end
	Financial leverage	*Lev*	Total liabilities at year/year-end assets
	Return on assets	*Roa*	Year-end net profit/year-end total assets
	Nature of property right	*Soe*	If the enterprise is state owned, the value is 1; otherwise, it is 0
	Enterprise age	*Age*	Natural logarithm of the company's founding years
	Fresh water consumption in industrial water use	*Water*	Fresh water consumption in industrial water (ton)/100,000
	Total number of employees at the end of the year	*Employee*	Average annual number of employees (10,000 persons)
	Number of pollutant processing equipment	*Equipment*	Number of wastewater treatment facilities + waste gas treatment facilities + desulfurization facilities

pollutant handling facilities (Equipment), and year-end total employees (Employee) as the control variables. At the same time, the interaction term Year*Province is added to the model to control the unobservable factors that change over time at the regional level. Specific variable definitions are shown in Table 1.

4.4 Descriptive statistics

Table 2 reports the descriptive statistics of the whole sample of the main variables. The mean value of the comprehensive index (EP) of enterprise pollution emissions is 3.074, the standard deviation is 13.620, and the maximum and minimum values are 95.200 and −0.031, respectively. The mean value of unit energy consumption (CEP) is 4.260, the standard deviation is 6.734, and the maximum and minimum values are 43.190 and 0, respectively, indicating that the environmental performance of the industrial enterprises in China is good, but there are great differences between different individuals. The average value of Treat is 0.176, that is, 17.6% of the enterprises are included in the NSMF program's list, which also shows that the overall environmental performance of China's industrial enterprises is good. The descriptive statistical values of the other variables are reasonably distributed and will not be repeated here.

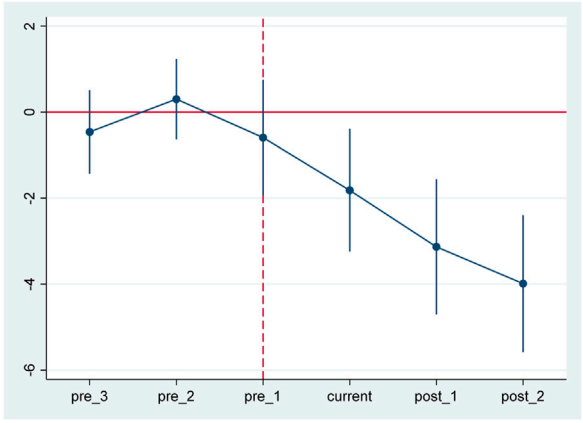

FIGURE 1
Parallel trend test.

10.3389/fenvs.2022.1070143

TABLE 2 Descriptive statistical analysis.

Variable	N	Mean	50%	Std. dev.	Min	Max
EP	10,006	3.074	-0.004	13.620	−0.031	95.200
CEP	10,006	4.260	1.357	6.734	0.000	43.190
Treat	10,006	0.176	0.000	0.381	0.000	1.000
Post	10,006	0.277	0.000	0.448	0.000	1.000
IM	10,006	0.740	1.000	0.439	0.000	1.000
FC	10,006	0.509	1.000	0.500	0.000	1.000
PGDP	10,006	1.613	1.299	1.070	0.416	5.047
Size	10,006	4.818	4.664	1.900	0.824	8.288
Lev	10,006	0.651	0.650	0.273	0.027	1.590
Roa	10,006	0.029	0.011	0.096	−0.237	0.702
Age	10,006	2.390	2.398	1.129	0.000	4.111
Soe	10,006	0.242	0.000	0.428	0.000	1.000
Employee	10,006	0.176	0.046	0.393	0.004	2.716
Equipment	10,006	10.410	6.000	11.610	0.000	40.000
Water	10,006	11.850	1.800	22.820	0.000	83.640

TABLE 3 Baseline regression results.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	EP	EP	EP	CEP	CEP	CEP
Treat*Post	−1.177**	−1.526***	−2.035***	−0.570**	−0.607**	−0.607**
	(−2.453)	(−3.173)	(−4.057)	(−2.079)	(−2.184)	(−2.048)
Size		−0.378	−0.564**		−0.033	0.011
		(−1.488)	(−2.192)		(−0.222)	(0.074)
Lev		0.441	0.324		−0.252	−0.220
		(0.728)	(0.533)		(−0.721)	(−0.612)
Roa		0.344	0.371		−0.574	−0.474
		(0.275)	(0.290)		(−0.794)	(−0.627)
Age		0.144	0.182		−0.214*	−0.222*
		(0.736)	(0.917)		(−1.891)	(−1.891)
Soe		−0.982	−0.683		−0.217	−0.130
		(−1.640)	(−1.120)		(−0.628)	(−0.361)
Employee		−1.405	−1.350		−0.259	−0.091
		(−1.218)	(−1.116)		(−0.389)	(−0.127)
Equipment		0.056**	0.068***		−0.024*	−0.023*
		(2.365)	(2.838)		(−1.734)	(−1.650)
Water		0.050***	0.046***		0.001	−0.000
		(3.646)	(3.337)		(0.064)	(−0.004)
Constant	2.822***	3.604***	6.854	4.987***	5.895***	−19.885
	(12.948)	(2.658)	(0.053)	(40.072)	(7.526)	(−0.261)
Year*Province	No	No	Yes	No	No	Yes
Year	Yes	Yes	No	Yes	Yes	No
Firm	Yes	Yes	Yes	Yes	Yes	Yes
N	10,006	10,006	10,006	10,006	10,006	10,006
Adj-R^2	0.004	0.030	0.109	0.028	0.030	0.068

Note: ***, **, and * are significant at the levels of 1%, 5%, and 10%, respectively, with T values in brackets. The same is given below.

5 Analyses and results

5.1 Parallel trend test

The premise of the difference-in-differences method is that the enterprises included in the NSMF program's list and the enterprises not included in the NSMF program's list meet the parallel trend hypothesis before the project runs. To this end, this article draws on the event research method of Li et al. (2016) for a parallel trend test. On the basis of model (1), the window period for variables of 1–3 years before the operation year of the NSMF program and the window period for variables of 1–2 years after the operation are added. The following regression model is set as

$$EP_{it} = \alpha + \beta_1 Treat_i * pre\_1 + \beta_2 Treat_i * pre\_2 + \beta_3 Treat_i * pre\_3 + \beta_0 Treat_i * current + \beta_4 Treat_i * post\_1 + \beta_5 Treat_i * post\_2 + \beta_6 Controls_i + year * province + Industry + \lambda + \mu + \varepsilon_{it}. \quad (4)$$

After adding the control variables, the regression coefficients of the explanatory variables $Treat_i$*pre_1, $Treat_i$*pre_2, and $Treat_i$*pre_3 were not significant,

10.3389/fenvs.2022.1070143

TABLE 4 NSMF program, financing constraints, and corporate environmental performance.

Variable	Low financing constraint				High financing constraint			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EP	EP	CEP	CEP	EP	EP	CEP	CEP
Treat*Post	−1.773**	−2.179***	−0.663**	−0.863***	−0.193	−0.194	−0.505	−0.132
	(−2.452)	(−2.882)	(−2.280)	(−2.786)	(−0.511)	(−0.436)	(−0.657)	(−0.152)
Size	−0.144	−0.455	0.130	0.139	−0.017	−0.044	−0.083	0.041
	(−0.267)	(−0.810)	(0.598)	(0.603)	(−0.126)	(−0.296)	(−0.294)	(0.142)
Lev	1.100	1.051	−0.539	−0.516	0.268	0.287	0.720	0.608
	(0.877)	(0.826)	(−1.068)	(−0.990)	(1.041)	(1.053)	(1.371)	(1.143)
Roa	0.586	−0.309	−0.636	−0.724	0.101	0.050	−0.735	0.328
	(0.199)	(−0.101)	(−0.537)	(−0.577)	(0.205)	(0.092)	(−0.729)	(0.312)
Age	0.447	0.450	−0.227*	−0.151	−0.002	0.025	−0.327	−0.041
	(1.330)	(1.297)	(−1.678)	(−1.059)	(−0.019)	(0.231)	(−1.569)	(−0.190)
Soe	−0.819	−0.189	−0.154	−0.069	−0.258	−0.062	−0.658	−0.322
	(−0.938)	(−0.209)	(−0.437)	(−0.188)	(−0.540)	(−0.117)	(−0.676)	(−0.315)
Employee	−0.283	−0.556	−0.253	0.057	−4.036	−3.438	1.229	2.183
	(−0.183)	(−0.336)	(−0.406)	(0.084)	(−0.846)	(−0.677)	(0.126)	(0.220)
Equipment	0.070**	0.097***	−0.036**	−0.041***	−0.005	0.010	0.005	0.014
	(1.962)	(2.643)	(−2.513)	(−2.718)	(−0.287)	(0.520)	(0.131)	(0.389)
Water	0.050***	0.046**	−0.008	−0.012	0.063***	0.066***	0.068**	0.057*
	(2.626)	(2.372)	(−1.055)	(−1.450)	(4.427)	(4.428)	(2.309)	(1.960)
Constant	3.084	−5.859	4.604***	−44.440	0.162	1.322	6.139***	10.035
	(0.872)	(−0.026)	(3.236)	(−0.477)	(0.287)	(0.023)	(5.322)	(0.090)
Year*Province	No	Yes	No	Yes	No	Yes	No	Yes
Year	Yes	No	Yes	No	Yes	No	Yes	No
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5,003	5,003	5,003	5,003	5,003	5,003	5,003	5,003
Adj-R^2	0.036	0.153	0.053	0.135	0.021	0.099	0.027	0.178

indicating that at least 3 years before the implementation of the policy, the trend of the pollutant discharge intensity and unit energy consumption of the treatment group and control group had been consistent, meeting the parallel trend hypothesis. To show the results more intuitively, we drew a graph as shown in Figure 1. It can be seen that before the operation of the national control project, the regression coefficients of $Treat_i$*pre_1, $Treat_i$*pre_2, and $Treat_i$*pre_3 are not significantly different from 0 (95% confidence interval contains 0), indicating that there is no significant difference between the treatment group and control group before the operation of the program, which satisfies the parallel trend hypothesis, while the coefficient after the operation of the project is significantly negative, indicating that the operation of the NSMF program has a negative impact on the pollutant discharge and unit energy consumption of the enterprise, that is, it improves the environmental performance of the enterprise [due to space limitations, this article only selects the report model (4) which includes more intuitive graphics].

TABLE 5 NSMF program, import/export enterprises, and corporate environmental performance.

Variable	Import enterprise				Export enterprise			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EP	EP	CEP	CEP	EP	EP	CEP	CEP
Treat*Post	−1.886***	−1.650***	−0.847**	−0.810*	−0.479	−1.623	−0.272	−0.350
	(−3.929)	(−3.261)	(−2.103)	(−1.832)	(−0.466)	(−1.472)	(−0.881)	(−1.049)
Size	0.016	−0.121	−0.186	−0.137	−1.131	−0.856	0.283	0.398
	(0.067)	(−0.497)	(−0.923)	(−0.645)	(−1.359)	(−0.979)	(1.136)	(1.505)
Lev	0.201	0.314	−0.127	−0.148	2.092	1.695	−0.886	−0.970
	(0.385)	(0.607)	(−0.290)	(−0.328)	(1.097)	(0.836)	(−1.550)	(−1.582)
Roa	−0.721	−0.627	−0.488	−0.494	7.706	6.664	−1.713	−0.869
	(−0.702)	(−0.605)	(−0.567)	(−0.546)	(1.515)	(1.239)	(−1.123)	(−0.534)
Age	0.291	0.324	−0.325**	−0.325*	−0.018	−0.065	0.037	0.034
	(1.481)	(1.631)	(−1.974)	(−1.870)	(−0.040)	(−0.136)	(0.275)	(0.238)
Soe	0.822	0.532	−0.211	−0.099	−3.124**	−2.852**	−0.112	−0.165
	(1.274)	(0.814)	(−0.391)	(−0.174)	(−2.527)	(−2.128)	(−0.301)	(−0.408)
Employee	5.490***	7.992***	−0.005	−0.010	−0.293	−1.696	0.035	−0.138
	(2.758)	(3.755)	(−0.003)	(−0.005)	(−0.119)	(−0.627)	(0.047)	(−0.169)
Equipment	0.046*	0.047*	−0.031	−0.023	0.059	0.088*	−0.019	−0.023
	(1.910)	(1.948)	(−1.545)	(−1.094)	(1.150)	(1.650)	(−1.207)	(−1.420)
Water	0.041***	0.045***	−0.003	0.004	0.082**	0.070**	0.011	0.014
	(3.026)	(3.295)	(−0.266)	(0.335)	(2.524)	(2.045)	(1.160)	(1.337)
Constant	−0.994	4.268	7.422***	−16.807	11.269**	8.999	1.273	−0.321
	(−0.823)	(0.046)	(7.326)	(−0.208)	(2.018)	(0.136)	(0.760)	(−0.016)
Year*Province	No	Yes	No	Yes	No	Yes	No	Yes
Year	Yes	No	Yes	No	Yes	No	Yes	No
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,407	7,407	7,407	7,407	2,599	2,599	2,599	2,599
Adj-R^2	0.028	0.172	0.036	0.108	0.029	0.215	0.027	0.200

5.2 Baseline regression results

The regression results of the basic relationship between the NSMF program and corporate environmental performance are shown in Table 3. Specifically, the regression results of the influences of the NSMF program on the comprehensive pollutant emission intensity of the enterprises are listed in columns (1)–(3). The regression results of the influences of the NSMF program on unit energy consumption of the enterprises are listed in columns (4)–(6). Control variables are added in column (3) and column (6). After time, individual and industrial fixed effects as well as regional unobservable factors that change with time are controlled, and the coefficients of Treat*Post are −2.035 and −0.607, which are significantly negative at the 5% level at least. Based on the aforementioned results, the implementation of the NSMF program inhibits the comprehensive pollutant emission intensity of enterprises and lowers their unit energy consumption, thus improving the enterprise environmental performance. Hence, H_1 is

10.3389/fenvs.2022.1070143

TABLE 6 NSMF program, economic development level, and corporate environmental performance.

Variable	High economic development level				Low economic development level			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	EP	EP	CEP	CEP	EP	EP	CEP	CEP
Treat*Post	−2.070***	−2.657***	−0.450	−0.448	−1.476	−1.461	−0.676	−0.619
	(−3.614)	(−4.518)	(−1.329)	(−1.241)	(−1.247)	(−1.178)	(−0.837)	(−0.728)
Size	−0.297	−0.409	0.080	0.013	−0.065	−0.119	−0.396	−0.212
	(−0.968)	(−1.347)	(0.439)	(0.070)	(−0.150)	(−0.267)	(−1.350)	(−0.691)
Lev	0.093	0.183	−0.424	−0.472	0.782	0.734	−0.048	0.093
	(0.120)	(0.239)	(−0.922)	(−1.005)	(0.887)	(0.818)	(−0.079)	(0.152)
Roa	0.089	0.833	−0.852	−0.873	−0.549	−1.408	1.852	2.825
	(0.066)	(0.621)	(−1.073)	(−1.062)	(−0.224)	(−0.552)	(1.108)	(1.614)
Age	0.559**	0.655**	−0.293*	−0.324**	−0.061	−0.130	−0.113	−0.117
	(2.126)	(2.495)	(−1.883)	(−2.016)	(−0.200)	(−0.406)	(−0.539)	(−0.533)
Soe	−3.229***	−2.893***	0.637	0.519	0.372	0.487	−0.378	−0.228
	(−3.233)	(−2.886)	(1.079)	(0.844)	(0.454)	(0.578)	(−0.676)	(−0.394)
Employee	3.142**	4.004***	−0.629	−0.262	7.208***	7.847***	0.057	−0.244
	(2.221)	(2.718)	(−0.753)	(−0.290)	(3.187)	(3.306)	(0.037)	(−0.150)
Equipment	0.069**	0.079***	−0.006	−0.011	0.088**	0.089**	−0.018	−0.014
	(2.286)	(2.645)	(−0.354)	(−0.575)	(2.247)	(2.241)	(−0.682)	(−0.520)
Water	0.027	0.011	−0.014	−0.015	−0.012	−0.013	0.020	0.016
	(1.491)	(0.598)	(−1.282)	(−1.341)	(−0.528)	(−0.585)	(1.286)	(1.013)
Constant	3.346**	1.388	5.046***	4.588***	0.350	1.383	7.558***	6.240***
	(2.011)	(0.767)	(5.127)	(4.135)	(0.155)	(0.548)	(4.910)	(3.604)
Year*Province	No	Yes	No	Yes	No	Yes	No	Yes
Year	Yes	No	Yes	No	Yes	No	Yes	No
Firm	Yes	Yes	Yes	Yes	Yes	YES	Yes	Yes
N	4,962	4,962	4,962	4,962	5,044	5,044	5,044	5,044
Adj-R^2	0.040	0.151	0.026	0.074	0.022	0.069	0.028	0.064

verified. Such an effect of the NSMF program is analyzed as follows. First, the NSMF program can decrease information asymmetry between the central government and local government and between the government and enterprises. It can deter enterprises and local governments such that the government can formulate more specific environmental regulations and facilitate full implementation to force enterprises to adopt energy savings and emission reduction. Second, it can strengthen the environmental protection consciousness of enterprises through information transmission and thereby strengthen their willingness to improve clean production technologies, purchase environmental protection equipment, and produce green products. Third, the NSMF program brings an innovative idea of environmental management and improves the overall environmental supervision and law enforcement efficacy. All of these factors facilitate the improvement of enterprise environmental performance and bring a new situation of energy savings and emission reduction in China.

10.3389/fenvs.2022.1070143

TABLE 7 Robustness test.

Variable	(1)	(2)	(3)	(4)	(5)
	EP	CEP	EP	CEP	LnCOD
Treat*Post	−0.168	−0.035	−1.377***	−0.610**	−0.187**
	(−0.368)	(−0.132)	(−2.896)	(−2.193)	(−2.022)
Size	−0.056	0.020	−0.421*	−0.032	0.069
	(−0.274)	(0.167)	(−1.677)	(−0.216)	(1.408)
Lev	0.656	−0.068	0.528	−0.255	0.041
	(1.357)	(−0.242)	(0.882)	(−0.728)	(0.351)
Roa	1.392	−0.508	0.871	−0.585	−0.074
	(1.321)	(−0.825)	(0.702)	(−0.807)	(−0.306)
Age	−0.120	−0.063	0.141	−0.213*	0.037
	(−0.827)	(−0.747)	(0.729)	(−1.883)	(0.982)
Soe	−0.710	−0.136	−0.977*	−0.215	−0.071
	(−1.438)	(−0.471)	(−1.650)	(−0.623)	(−0.615)
Employee	−0.102**	−0.009	−0.010	−0.003	0.311
	(−2.453)	(−0.381)	(−0.880)	(−0.431)	(1.403)
Equipment	0.086***	0.000	0.056**	−0.024*	0.011**
	(4.239)	(0.024)	(2.400)	(−1.731)	(2.485)
Water	0.048***	−0.013**	0.050***	0.001	0.026***
	(4.282)	(−2.035)	(3.697)	(0.066)	(9.787)
Constant	−2.299	19.900***	3.672***	5.894***	8.299***
	(−0.453)	(6.708)	(2.739)	(7.518)	(31.808)
Year	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes
N	10,006	10,006	9,995	9,995	10,006
Adj-R^2	0.089	0.092	0.027	0.030	0.039

5.3 Heterogeneity analysis

5.3.1 NSMF program, financing constraint, and corporate environmental performance

To test whether the influences of the NSMF program on corporate environmental performance are impacted by financing constraints, sample data are divided into a low financing constraint group and high financing constraint group in this study. The regression results are shown in Table 4. Columns (1), (2), (5), and (6) are the "emission reduction" effect of the NSMF program. After relevant factors are controlled, the Treat*Post coefficients of the low financing constraint group and high financing constraint group are −2.179 and −0.194, respectively. The former is significantly negative at the 1% level, while the latter is not significant. Columns (3), (4), (7), and (8) are the "energy saving" effect of the project. After relevant factors are controlled, the Treat*Post coefficients of the low financing constraint group and high financing constraint group are −0.863 and −0.132, respectively. The former is significantly negative at the 1% level, while the latter is not significant. Based on the aforementioned results, the NSMF program decreases the comprehensive pollutant emission intensity and unit energy consumption of the enterprises with low financing constraints. However, it fails to exert significant effects on the "emission reduction" and "energy saving" of the enterprises with high financing constraints. In other words, the NSMF program improves the environmental performance of enterprises with low financing constraints more significantly than that of enterprises with high financing constraints. Hence, H_2 is verified. According to the analysis, enterprises with high financing constraints may decrease investment in environmental protection to the maximum extent and reject the installation and maintenance of automatic pollution source supervision equipment due to financial pressure. From the perspective of the "rational economic man," the primary goal of enterprises with high financing constraints is to expand production. Only enterprises with low financing constraints have enough capital and motivation to improve clean production technologies and make innovations in green production activities.

TABLE 8 NSMF program, investment, and corporate environmental performance.

Variable	(1)	(2)	(3)
	EP	Invest	EP
Treat*Post	−1.944***	0.373**	−1.941***
	(−3.957)	(2.104)	(−3.947)
Invest			−0.008
			(−0.170)
Size	−0.264	0.206**	−0.262
	(−1.016)	(2.195)	(−1.008)
Lev	0.441	0.173	0.442
	(0.715)	(0.779)	(0.717)
Roa	0.570	0.002	0.570
	(0.452)	(0.004)	(0.452)
Age	0.234	−0.260***	0.232
	(1.158)	(−3.564)	(1.145)
Soe	−1.316**	−0.058	−1.317**
	(−2.081)	(−0.256)	(−2.082)
Employee	−0.212	−0.407**	−0.215
	(−0.430)	(−2.293)	(−0.436)
Export	−1.047	0.655	−1.042
	(−0.872)	(1.513)	(−0.867)
Water	0.050***	−0.003	0.049***
	(6.306)	(−0.899)	(6.302)
Constant	−4.313	1.183	−4.303
	(−0.889)	(0.676)	(−0.887)
Year	Yes	Yes	Yes
Firm	Yes	Yes	Yes
N	10,006	10,006	10,006
Adj-R^2	0.068	0.084	0.068

5.3.2 NSMF program, import/export enterprises, and corporate environmental performance

To test whether the influences of the NSMF program on corporate environmental performance are impacted by domestic marketing or export properties, sample data are divided into domestic marketing enterprise group and export enterprise group in this study. The regression results are shown in Table 5. Columns (1) and (2) of Table 5 show that the Treat*Post coefficients for the group of domestic firms are −1.886 and −1.650, which are significantly negative at the 1% level. Columns (3) and (4) show that the Treat*Post coefficients for the group of domestic firms are −0.847 and −0.810, respectively, which are significantly negative at the 5% and 10% levels, while the Treat*Post coefficients for the group of exporting firms are not significant. It shows that the NSMF program significantly reduces the comprehensive emission intensity and unit energy consumption of domestic enterprises and not only promotes "energy conservation and emission reduction" of domestic enterprises but also has no significant effect on export enterprises, which verifies H3. According to the analysis, when compared with domestic enterprises, export enterprises face more stringent environmental requirements. To meet the

TABLE 9 Bootstrap regression results.

Intermediary path	Effect value	Confidence interval
NSMF program → invest → corporate environmental performance	0.769***	[0.422,1.115]

environmental standards of developed countries, export enterprises must reduce pollution to obtain environmental certification of developed countries. In addition, when participating in the global export market, export enterprises can access the most advanced production and manufacturing, technology research and development, and management methods of developed countries. When compared with domestic enterprises, export enterprises have the opportunity to obtain more green production technologies to improve their own environmental performance. Therefore, the NSMF program can better promote the improvement of environmental performance of domestic enterprises.

5.3.3 NSMF program, economic development level, and corporate environmental performance

The level of economic development in the location of the enterprise also restricts the decision-making of resource allocation. In this article, the sample data are divided into higher level economic development group and lower level economic development group. The regression results are shown in Table 6. Columns (1) and (2) of Table 6 show that the NSMF program significantly reduces the comprehensive emission intensity of enterprises in regions of higher economic development levels and has no significant inhibitory effect on the unit energy consumption of enterprises in the region nor has any significant impact on the environmental performance of enterprises in regions of lower economic development levels. This may be because in areas with low levels of economic development, the primary task of the local governments is to promote economic development due to the pressure of performance appraisal, thus increasing the bargaining power of heavily polluting enterprises and ultimately weakening the improvement effect of state-controlled projects on the environmental performance of local enterprises.

5.4 Robustness test

5.4.1 Placebo test

For the sake of robustness, this article refers to Tang et al. (2022) and conducts a counterfactual test by changing the policy implementation time of the NSMF program. To exclude the influence of other policies and random factors, this article assumes that the NSMF program was implemented in 2005. If the regression results show that the coefficient of Treat*Post is no longer significant, then the improvement in corporate environmental performance comes from the implementation of the NSMF program. Columns (1) and (2) of Table 7 provide the regression results of the policy implementation point for 2005. The results show that if the NSMF program is implemented in 2005, the cross term of Treat*Post is no longer significant whether the dependent variable is the comprehensive emission intensity of the enterprise or the unit energy consumption of the enterprise, excluding the influence of other policies and random factors, confirming that the improvement of corporate environmental performance comes from the implementation of the NSMF program.

5.4.2 PSM-DID

To eliminate "selection bias" of the control group and treatment group, the reliability of the conclusions in this study was further verified by PSM-DID. All control variables were used as covariants during propensity score matching. The key monitored enterprises and the remaining enterprises were matched, and the observation values that failed to meet the common area hypothesis were eliminated. Finally, 9,995 observation values were obtained. The control group was built by nearest neighbor matching, and the matching ratio was 1:1. Moreover, DID model regression was carried out based on the matched samples. The regression results are shown in columns (3) and (4) of Table 7. Clearly, the Treat*Post coefficients of the explained variables, comprehensive pollutant emission intensity, and unit energy consumption are all significantly negative. The results are also robust, which is consistent with the conclusions of this study.

5.4.3 Replace dependent variable

Zhang et al. (2018) noted that chemical oxygen demand is a pollutant emitted by most industrial enterprises, which has become a key indicator of routine monitoring in China and a key indicator of the environmental performance of local governments in China. Therefore, to ensure the robustness of the aforementioned results, this article refers to the research of Zhang et al. (2018) and uses the emissions of chemical oxygen demand of enterprises as an alternative variable of environmental performance. The regression results are listed in column (5) of Table 7. The results show that the coefficient of Treat*Post is −0.187, which is still significantly negative at the 5% level, indicating that the NSMF program has significantly improved the environmental performance of enterprises, which is consistent with previous conclusions.

5.5 Mechanism test

Previously, it has been confirmed that the NSMF program can significantly reduce the comprehensive emission intensity and unit energy consumption of enterprises and improve the environmental performance of enterprises. So how is this achieved? In the aforementioned theoretical analysis and research hypothesis section, it is mentioned that the NSMF program can not only alleviate information asymmetry but also effect signal transmission and rule of law. These characteristics force enterprises to install automatic monitoring equipment and carry out environmental governance. Specifically, within the enterprise, resources may be reconfigured, such as purchasing more environmental protection equipment to improve the environmental performance. Therefore, this article takes "waste gas treatment capacity" as the proxy variable of enterprise environmental protection investment to test whether the NSMF program can reduce its comprehensive emission intensity and unit energy consumption by increasing the investment in enterprise environmental protection equipment. Following Wen and Ye (2014), we set the following model:

$$EP_{it}\left(CEP_{it}\right) = \alpha + cTreat_{\mathrm{i}}{*}Post_{\mathrm{t}} + \beta_2 Controls_{\mathrm{i}} + \lambda + \mu + Year{*}Province + Industry + \varepsilon_{\mathrm{it}}, \quad (5)$$

$$Invest_{it} = \alpha + aTreat_{\mathrm{i}}{*}Post_{\mathrm{t}} + \beta_2 Controls_{\mathrm{i}} + \lambda + \mu + Year{*}Province + Industry + \varepsilon_{\mathrm{it}} \quad (6)$$

$$EP_{it}\left(CEP_{it}\right) = \alpha + c'Treat_{\mathrm{i}}{*}Post_{\mathrm{t}} + bInvest_{it} + \beta_2 Controls_{\mathrm{i}} + \lambda + \mu + Year{*}Province + Industry + \varepsilon_{\mathrm{it}} \quad (7)$$

where Invest is the enterprise environmental protection equipment investment calculated from "enterprise waste gas treatment facilities processing capacity (in standard cubic meters)/100,000." Eq. 5 tests the impact of the NSMF program on corporate environmental performance, which has been verified above. Eq. 6 tests the influence of the NSMF program on enterprise environmental protection equipment input and observes the significance of coefficient a. Eq. 7 takes the NSMF program and enterprise environmental protection equipment input as core explanatory variables for regression to observe the significance of coefficients c' and b. If coefficients a and b are significant and coefficient c' is significant, it indicates that the investment in environmental protection equipment is a part of the mediator. If the coefficient c' is not significant, it indicates that the investment in environmental protection equipment is a complete intermediary. If at least one of the coefficients a and b is not significant, the bootstrap method should be used for further testing. The regression results are shown in Table 8. The results show that the coefficient of invest is not significant, so it is necessary to further conduct the bootstrap test. The bootstrap test results (Table 9) show that the indirect effect of enterprise environmental protection equipment investment on the improvement of corporate environmental performance of the NSMF program is significant. This indicates that the increase in investment in environmental protection equipment is a non-exclusive intermediary mechanism for the NSMF program to improve corporate environmental performance.

6 Conclusion and implications

6.1 Conclusion

In China, the realization of the central ecological environment governance goal deeply depends on the transformation mechanism of the environmental policy implementation chain at the local level. However, under the state of incomplete information and the incentive structure of multitasking principal–agent, there are many principal–agent problems which lead to the destruction of the transformation mechanism of the policy implementation chain and the failure to achieve the goal of environmental governance. In view of this, based on the Chinese industrial enterprise pollution database and the Chinese industrial enterprise database, this article selects industrial enterprise data from 2001 to 2009 as the research sample, empirically tests the impact and mechanism of the NSMF program on the environmental performance of enterprises, and further examines the different effects of enterprise heterogeneity and regional differences on the relationship between the two. The empirical results show the following: 1) the implementation of the NSMF program has significantly improved corporate environmental performance. 2) When compared with enterprises with a high degree of financing constraints, the NSMF program has a more significant effect on the environmental performance of enterprises with a low degree of financing constraints; when compared with export enterprises, the NSMF program has a more significant effect on the environmental performance of domestic enterprises; when compared with enterprises with a lower economic development level in the region, the NSMF program has a more significant effect on the environmental performance of enterprises with a higher economic development level in the region. 3) The mechanism tests show that the NSMF program can improve environmental performance by increasing investment in environmental protection equipment.

6.2 Practical implications

The conclusion of this study has important policy implications for optimizing China's future environmental governance. First, the central government should strengthen local environmental supervision. On the one hand, more

flexible and comprehensive central supervision and environmental decentralization of environmental policies should be adopted. For many years, the ambiguity and conflict of China's environmental regulations have tended to stimulate the interest game between the local government and central government in the implementation process. Therefore, it is urgent to use modern means to improve the intensity and precision of environmental governance to reduce the space of discretion in the implementation of environmental policies and exercise authority. On the other hand, the proportion of the environmental governance effect in the promotion assessment of local officials should be increased. The monitoring data of the NSMF program are integrated with the environmental governance data obtained by "man-marking" to comprehensively evaluate the environmental governance performance of all provinces and regions, ranking them regularly, rewarding provinces with good environmental control, and increasing punishment for provinces with poor environmental control to correct the GDP-only mentality of local governments.

Second, we fully consider the possible impact of heterogeneity of the enterprise's own resources. First, the construction of an environmental credit rating system should be strengthened for domestic enterprises or enterprises with higher financing constraints. Governments should provide appropriate economic resources, such as environmental subsidies, tax rebates, and even cooperation opportunities, to encourage the sustainable implementation of environmentally friendly behavior for reputable exporters who voluntarily fulfill their environmental responsibilities or those with higher financing constraints. Second, domestic enterprises or enterprises with higher financing constraints should be encouraged to coordinate with universities and research institutions. The government should give certain subsidies and rewards to this series of cooperation, minimize the investment and risk of green technology R&D of domestic enterprises or enterprises with higher financing constraints, and reduce their cost pressure in improving environmental performance. Third, China's international division of labor status should be enhanced. On the one hand, in facing the new situation of economic globalization, we should continue to promote the process of opening up to the outside world, implement a more active export strategy, make full use of the regional cooperation platform built by the "Belt and Road," and encourage enterprises to participate in globalization to higher and higher levels. On the other hand, the construction of an enterprise resource sharing network encourages export enterprises and domestic enterprises to engage in green technology exchange and emission reduction equipment sharing and promote enterprise green technology progress and emission reduction equipment upgrades to obtain more environmental benefits.

Third, we should strengthen the application effect of monitoring data and improve our environmental monitoring system. On the one hand, we should give full play to the unique advantages of the NSMF program and eliminate information noise and other interference factors caused by the principal–agent relationship in environmental governance to ensure the integrity and smoothness of the implementation chain of environmental policies and ultimately maximize the effect of the environmental governance system. On the other hand, the data monitored by the NSMF program should be widely used in all walks of life. The wide application of monitoring data will improve the public's attention to the performance of corporate social responsibility, promote the public's wide participation in environmental governance, and facilitate government managers, enterprises, and scholars in various fields to explore the path of green development.

6.3 Limitations and future research

While this study validates the target findings, it also has certain limitations that need to be addressed in future research. First, the data selected in this article are all from the Chinese industrial enterprise pollution database and the Chinese industrial enterprise database, which is considered to be the most comprehensive and reliable environmental microeconomic data in China. However, data from both databases are not updated to the most recent year. In the future, we can further explore how to measure corporate environmental performance more intuitively using the latest data. Second, there is the intermediary effect. This study not only focuses on the intermediary role of investment in environmental protection equipment but also shows that investment in environmental protection equipment is not the only intermediary mechanism by which the NSMF program improves enterprises' environmental performance. Future research can explore the synergy mechanism of the NSMF program affecting enterprises' environmental performance. Finally, there is a balance between environmental performance and economic performance. Although the NSMF program is essential to alleviate the principal–agent problem in the process of corporate environmental governance and can effectively improve the environmental performance of enterprises, it is still necessary to explore whether the NSMF program can improve the environmental performance of enterprises while considering economic performance to make the research conclusion more comprehensive.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

Author contributions

All authors have contributed to the study of concepts and design. TZ, CX, and HL conceived and designed the research, analyzed the data, and wrote and revised the manuscript. JL proofread and edited the manuscript.

Funding

The research was sponsored by a general program of the National Social Science Foundation of China "Research on the audit coordination mechanism of compound treatment of river basin water pollution under the concept of green development" (21BJY121).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, editors, and reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Aghion, P., Antoine, D., David, H., Ralf, M., Reenen, V., et al. (2016). Carbon taxes, path dependency, and directed technical change: Evidence from the auto industry. *J. Political Econ.* 124 (1), 1–51. doi:10.1086/684581

Bloom, N., Schankerman, M., and Reenen, J. V. (2013). Identifying technology spillovers and product market rivalry. *Econometrica* 81 (4), 1347–1393. doi:10.3982/ECTA9466

Brandt, L., Van Biesebroeck, J., and Zhang, Y. (2012). Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing. *J. Dev. Econ.* 97 (2), 339–351. doi:10.3386/w15152

Cao, H., Zhang, L., Qi, Y., Yang, Z., and Li, X. (2021). Government auditing and environmental governance: Evidence from China's auditing system reform. *Environ. Impact Assess. Rev.* 93, 106705. doi:10.1016/j.eiar.2021.106705

Chen, Y., Jin, G. Z., Kumar, N., and Shi, G. (2012). Gaming in air pollution data: Lessons from China. *BE J. Econ. Analysis Policy* 12 (3), 1–43. doi:10.3386/w18729

Chen, Z., Chen, F., and Zhou, M. (2021). Does social trust affect corporate environmental performance in China? *Energy Econ.* 102, 105537. doi:10.1016/j.eneco.2021.105537

De Loecker, J., and Goldberg, P. K. (2014). Firm performance in a global market. *Annu. Rev. Econ.* 6 (1), 201–227. doi:10.1146/annurev-economics-080113-104741

Du, J., and Mickiewicz, T. (2016). Subsidies, rent seeking and performance: Being young, small or private in China. *J. Bus. Ventur.* 31 (1), 22–38. doi:10.1016/j.jbusvent.2015.09.001

Earnhart, D., Glicksman, R. L., and Harrington, D. R. (2020). The effect of enforcement fairness on environmental performance. *Environ. Manag. Sustain. Dev.* 9 (2), 1. doi:10.5296/emsd.v9i2.16708

Endo, K. (2019). Does the stock market value corporate environmental performance? Some perils of static regression models. *Corp. Soc. Responsib. Environ. Manag.* 26, 1530–1538. doi:10.1002/csr.1767

Fang, J., Gao, C., and Lai, M. (2020). Environmental regulation and firm innovation: Evidence from national specially monitored firms program in China. *J. Clean. Prod.* 271, 122599. doi:10.1016/j.jclepro.2020.122599

Francoeur, C., Lakhal, F., Gaaya, S., and Saad, B. I. (2020). How do powerful CEOs influence corporate environmental performance? *Econ. Model.* 94 (4), 121–129. doi:10.1016/j.econmod.2020.09.024

Gao, L., Li, Z., Wang, J., and Wang, Y. (2020). Analysis and suggestions on the application of automatic monitoring data of pollution sources to administrative law enforcement. *J. Environ. Prot.* 48 (10), 65–69. doi:10.14026/j.cnki.0253-9705.2020.10.014

Gupta, S., Saksena, S., and Baris, O. F. (2019). Environmental enforcement and compliance in developing countries: Evidence from India. *World Dev.* 117, 313–327. doi:10.1016/j.worlddev.2019.02.001

Hart, S. L., and Ahuja, G. (1996). Does it pay to Be Green?An empirical examination of the relationship between emission reduction and firm performance. *Bus. Strategy Environ.* 5 (1), 30–37. doi:10.1002/(sici)1099-0836(199603)5:1<30::aid-bse38>3.0.co;2-q

Hashmi, R., and Alam, K. (2019). Dynamic relationship among environmental regulation, innovation, CO2 emissions, population, and economic growth in OECD countries: A panel investigation. *J. Clean. Prod.* 231, 1100–1109. doi:10.1016/j.jclepro.2019.05.325

He, L., Zhong, T., Gan, S., Liu, J., and Xu, C. (2022). Penalties vs. Subsidies: A study on which is better to promote corporate environmental governance. *Front. Environ. Sci.* 10, 859591. doi:10.3389/fenvs.2022.859591

Holmstrom, B., and Milgrom, P. (1991). Multitask principal-agent analyses: Incentive contracts, asset ownership, and job design. *J. Law Econ. Organ.* 7, 232–244. doi:10.1017/cbo9780511817410.018

Jiang, C., Liu, R., and Han, J. (2022). Does accountability audit of natural resource promote corporate environmental performance? An external supervision perspective. *Environ. Dev. Sustain.* doi:10.1007/s10668-022-02441-0

Johan, G., and Lans, B. (2020). Government regulation, business leaders' motivations and environmental performance of SMEs. *J. Environ. Plan. Manag.* 63 (8), 1335–1355. doi:10.1080/09640568.2019.1663159

Khanna, M., and Anton, W. R. Q. (2002). Corporate environmental management: Regulatory and market-based incentives. *Land Econ.* 78 (4), 539–558. doi:10.2307/3146852

Konar, S., and Cohen, M. A. (2001). Does the market value environmental performance? *Rev. Econ. Statistics* 83 (2), 281–289. doi:10.1162/00346530151143815

Kostka, G., and Mol, A. P. J. (2013). Implementation and participation in China's local environmental politics: Challenges and innovations. *J. Environ. Policy & Plan.* 15 (1), 3–16. doi:10.1080/1523908x.2013.763629

Li, P., Lu, Y., and Wang, J. (2016). Does flattening government improve economic performance? Evidence from China. *J. Dev. Econ.* 123, 18–37. doi:10.1016/j.jdeveco.2016.07.002

Li, R. Q., Zhou, Y. C., Bi, J., Liu, M., and Li, S. S. (2020). Does the central environmental inspection actually work? *J. Environ. Manag.* 253, 109602. doi:10.1016/j.jenvman.2019.109602

Lu, J. (2022). Can the central environmental protection inspection reduce transboundary pollution? Evidence from river water quality data in China. *J. Clean. Prod.* 332, 130030. doi:10.1016/j.jclepro.2021.130030

Muller, N. Z., Mendelsohn, R., and Nordhaus, W. (2011). Environmental accounting for pollution in the United States economy. *Am. Econ. Rev.* 101 (5), 1649–1675. doi:10.1257/aer.101.5.1649

Orlitzky, M., Schmidt, F. L., and Rynes, S. L. (2003). Corporate social and financial performance: A meta-analysis. *Organ. Stud.* 24 (3), 403–441. doi:10.1177/0170840603024003910

Peng, B., Sheng, X., and Wei, G. (2020). Does environmental protection promote economic development? From the perspective of coupling coordination between environmental protection and economic development. *Environ. Sci. Pollut. Res.* 36, 39135–39148. doi:10.1007/s11356-020-09871-1

Rick, H., Rachna, S., and Suvrat, D. (2021). The impact of a spill or pollution accident on firm environmental activity: An empirical investigation. *Prod. Operations Manag.* 30 (8), 2467–2491. doi:10.1111/poms.13392

Roy, J., and Yasar, M. (2015). Energy efficiency and exporting: Evidence from firm-level data. *Energy Econ.* 52, 127–135. doi:10.1016/j.eneco.2015.09.013

Shen, H. G., and Zhou, Y. K. (2017). Environmental law enforcement supervision and enterprise environmental performance: Quasi natural experimental evidence from environmental interviews. *Nankai Manag. Rev.* 20 (6), 73–82.

Su, D. (2020). How global value chain embeddedness affects environmental performance of Chinese enterprises. *J. Nankai Econ. Study* 5, 66–86. doi:10.14116/j.nkes.2020.05.004

Su, Y., and An, X. (2018). Application of threshold regression analysis to study the impact of regional technological innovation level on sustainable development. *Renew. Sustain. Energy Rev.* 89, 27–32. doi:10.1016/j.rser.2018.03.005

Sun, X., Wang, W., Pang, J., Liu, X., and Zhang, M. (2021). Study on the evolutionary game of central government and local governments under central environmental supervision system. *J. Clean. Prod.* 296, 126574. doi:10.1016/j.jclepro.2021.126574

Tang, G., Sun, H., and Chen, X. (2022). Carbon emission trading system and enterprise investment behavior. *J. Financial Theory Ser.* 4, 57–68. doi:10.13762/j.cnki.cjlc.2022.04.003

Tang, R. (2015). Environmental regulation and firm innovation: Evidence from China. Working paper. Available at: http://www. ualberta. ca/-econphd/Ruotao_Tang_JMP . pdf.

Tao, H., Zhuang, S., Xue, R., Cao, W., Tian, J., and Shan, Y. (2022). Environmental finance: An interdisciplinary review. *Technol. Forecast. Soc. Change* 179, 121639. doi:10.1016/j.techfore.2022.121639

Tian, J., Yu, L., Xue, R., Zhuang, S., and Shan, Y. (2022). Global low-carbon energy transition in the post-COVID-19 era. *Appl. Energy* 307, 118205. doi:10.1016/j.apenergy.2021.118205

Torres, H. R. (1999). The trade and environment interaction in the WTO: How can a "New Round" contribute? *J. World Trade* 33 (5), 153–167. doi:10.54648/trad1999037

Tran, N. M., and Pham, B.-N. T. (2020). The influence of CEO characteristics on corporate environmental performance of SMEs: Evidence from Vietnamese SMEs. *Manag. Sci. Lett.* 10 (8), 1671–1682. doi:10.5267/j.msl.2020.1.013

Van Rooij, B. (2016). "The campaign enforcement style: Chinese practice in context and comparison," in *Comparative law and regulation: Understanding the global regulatory process*, 217–237. doi:10.4337/9781782545613.00019

Van Rooij, B. (2006). Implementation of Chinese environmental law: Regular enforcement and political campaigns. *Dev. Change* 37 (1), 57–74. doi:10.1111/j.0012-155x.2006.00469.x

Wang, H., Chen, S., and Meng, T. (2021). Executives' public experience, central environmental supervision and corporate environmental performance——an empirical analysis based on enterprise level data of A province. *J. Public Manag.* 18 (01), 114–125+173. doi:10.16149/j.cnki.23-1523.2021.01.002

Wang, J., Dong, H., and Xiao, R. (2022). Central environmental inspection and corporate environmental investment: Evidence from Chinese listed companies. *Environ. Sci. Pollut. Res.* 29 (37), 56419–56429. doi:10.1007/s11356-022-19538-8

Wen, Z., and Ye, B. (2014). Analyses of mediating effects: The development of methods and models. *Adv. Psychol. Sci.* 22 (5), 731–745. doi:10.3724/SP.J.1042.2014.00731

Wu, X., Cao, Q., Tan, X., and Li, L. (2020). The effect of audit of outgoing leading officials' natural resource accountability on environmental governance: Evidence from China. *Manag. Auditing J.* 35 (9), 1213–1241. doi:10.1108/maj-08-2019-2378

Yang, X., Jiang, P., and Pan, Y. (2020). Does China's carbon emission trading policy have an employment double dividend and a Porter effect? *Energy Policy* 142, 111492. doi:10.1016/j.enpol.2020.111492

Yin, J., Gong, L., and Wang, S. (2018). Into the "punishment cage": Does dishonesty punishment inhibit enterprise innovation?——evidence from key monitoring enterprises of state control of wastewater. *J. Beijing Univ. Technol. Soc. Sci.* 20 (06), 9–17. doi:10.15918/j.jbitss1009-3370.2018.5105

Yin, J., Zhang, L., and Gong, L. (2020). Policy uncertainty and innovation of heavily polluting enterprises : Evidence from key monitoring enterprises of wastewater control. *J. Beijing Univ. Technol. Soc. Sci.* 22 (5), 23–31. doi:10.15918/j.jbitss1009-3370.2020.1693

Yu, X. (2016). Central–local conflicts in China's environmental policy implementation: The case of the sloping land conversion program. *Nat. Hazards* 84 (1), 77–96. doi:10.1007/s11069-016-2339-4

Yuan, W. Q., and Cao, J. G. (2017). The legal dilemma of automatic monitoring of pollution sources and its institutional improvement -- from the perspective of a rule of law government. *J. South China Normal Univ. Soc. Sci. Ed.* 1, 136–141+191.

Zhang, B., Chen, X., and Guo, H. (2018). Does central supervision enhance local environmental enforcement? Quasi-Experimental evidence from China. *J. Public Econ.* 164, 70–90. doi:10.1016/j.jpubeco.2018.05.009

Zhang, Y. F., Li, S., and Luo, Y. (2019). Evaluation of households' willingness to accept the ecological restoration of rivers flowing in China. *Environ. Prog. Sustain. Energy* 38 (4), 13094. doi:10.1002/ep.13094

Zhao, X., Zhao, Y., Zeng, S., and Zhang, S. (2015). Corporate behavior and competitiveness: Impact of environmental regulation on Chinese firms. *J. Clean. Prod.* 86, 311–322. doi:10.1016/j.jclepro.2014.08.074

Zhou, Y., Fu, J., Kong, Y., and Wu, R. (2018). How foreign direct investment influences carbon emissions, based on the empirical analysis of Chinese urban data. *Sustainability* 10 (7), 2163. doi:10.3390/su10072163

Zhou, Y., Luo, L., and Shen, H. (2021). Community pressure, regulatory pressure and corporate environmental performance. *Aust. J. Manag.* 47, 368–392. doi:10.1177/03128962211017172

Zhu, B., Xu, C., Wang, P., and Zhang, L. (2022). How does internal carbon pricing affect corporate environmental performance? *J. Bus. Res.* 145, 65–77. doi:10.1016/j.jbusres.2022.02.071

Zou, H. L., Zeng, S. X., Lin, H., and Xie, X. M. (2015). Top executives' compensation, industrial competition, and corporate environmental performance. *Manag. Decis.* 53 (9), 2036–2059. doi:10.1108/md-08-2014-0515