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# How does the new environmental protection law affect the environmental social responsibility of enterprises in Chinese heavily polluting industries?

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In the new era of seeking for cleaner production and comfortable life, it is important and necessary to improve environmental social responsibility, especially for the heavily polluting industries. Against this backdrop, the Chinese government put forward the new environmental protection law in 2015, while the effect of it on the environmental social responsibility still remains as a black box, which forms the initial motivation of this essay. Treating the implementation of the new environmental protection law (*NEPL*) as a quasi-natural experiment, this essay employed the difference-in-differences model to explore its impact on the environmental social responsibility (*ESR*) of highly polluting enterprises. The results support that implementing the NEPL can enhance the level of environmental social responsibility by strengthening the end-of-pipe governance and green office level of enterprises, in contrast, the affection on the front-end governance is not significant. The results remain unchanged after various robustness tests, such as changing the time point of the policy, placebo test, and elimination of sample selection bias. Further research finds that the scale of corporate financing and the efficiency of capital use have different moderating effects on the effectiveness of the implementation of the NEPL policy. Mechanism analysis shows that the NEPL policy affects the level of corporate environmental social responsibility through the technological innovation crowding-out effect. In addition, heterogeneity analysis reveals that environmental regulation intensity has an “inverted U-shaped” effect on the ESR of businesses. Furthermore, non-state-owned companies and companies with higher levels of executive education have higher levels of environmental social responsibility. Finally, policy implications are provided to shed light on this essay’s theoretical and practical values.

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## Introduction

Since the reform and opening up, heavy-polluting enterprises, such as thermal power and steel, have played an important role in China's economic development, but their extensive development mode has also brought a lot of environmental pollution problems, hindering the current construction of ecological civilization in China. A report of the 20th National Congress raised the construction of ecological civilization to a new height, planning growth from the standpoint of the peaceful coexistence of humans and nature, highlighting the need to execute the tightest ecological environmental protection system, and that a life-long system of responsibility for damage to the ecological environment should be established. Based on this, it is urgent to strengthen environmental legislation. In this regard, the newly revised Environmental Protection Law of the People's Republic of China came into effect on January 1, 2015, enhancing the regulatory duties of national and local governments as well as the environmental governance restrictions placed on polluting companies. As an important policy tool to promote the construction of ecological civilization, the new environmental protection law (hereinafter referred to as the NEPL) has the dual responsibility of strengthening ecological protection and promoting economic development and is committed to changing the behavior choices of enterprises.

Under the modern environmental regulation system, enterprise behavior selection is critical to the transformation of industrial structure and production mode, and eventually affects the environmental regulation implementation effect. As the focus of environmental governance, under the background of strong pollution control by the government, the environmental pressure faced by heavy-polluting enterprises increases with the strengthening of regulation intensity. Especially in recent years, the sustainable impacts of corporate environmental and social activities have gradually attracted attention as public awareness of environmental protection increases (Kitzmueller and Shimshack, 2012), and the study of corporate social responsibility as well as sustainability issues has received increasing attention from scholars, policymakers, and practitioners (Post et al., 2011; Lu et al., 2019). This is mainly because the willingness of enterprises to bear social responsibility has a direct impact on the implementation effect of environmental protection policies. As an important source of pollution output, their production activities and their economic dynamic bias are crucial to environmental protection. Only when more enterprises are willing to bear their own environmental and social responsibilities can they finally achieve green production. However, there is often a contradiction between undertaking environmental social responsibility and maximizing their interests. Therefore, how to guide enterprises to assume more environmental social responsibility (hereinafter referred to as the ESR) through institutional innovation is a key issue in balancing resource allocation efficiency and green development, and exploring the different impacts of the implementation of the NEPL policy on the change of corporate responsibility behaviors has also become the main research question of this paper.

There is a contradiction between the limited resources of enterprises and the achievement of environmental goals, especially for heavy-polluting enterprises with strong dependence on resources, the contradiction is essentially a contradiction between resource allocation and externality. In this relationship, can the implementation of the NEPL be the lubricant to adjust the contradiction? As an important participant in responding to the national call for green development, can enterprises, under the double pressure of the public's demand for environmental protection and the NEPL policy's iron fist to combat pollution, achieve a change in their environmentally responsible behaviors?

As a command-and-control environmental regulatory tool, can the NEPL policy be used as an auxiliary means to regulate the environmental behavior of enterprises? As scholars have pointed out, examining how environmental regulatory policies affect corporate ESR can provide new empirical evidence for existing studies to better understand what environmental regulatory tools can be used to better promote corporate ESR (Wahba, 2008; Shaikat et al., 2016), which is the origin of this paper's research. Investigating whether the new environmental laws and regulations can effectively affect businesses' environmental protection efforts and improve the creation of future governmental environmental protection policies and sustainable development is highly significant from both a theoretical and practical standpoint in this context.

According to the above research questions, this paper summarizes some studies related to the theme: First, the interpretation and measurement of the connotation of ESR. Zhang (2017) and Phan et al. (2021) define corporate ESR as the enterprise's use of resources for the governance of environmental issues and the integration of environmental protection concepts into its production process and strategic arrangements. In addition, the level of environmental information disclosure is mainly composed of ten parts, including environmental investment expenditure (Liu and Anbumozhi, 2009), which is the most commonly used way of measuring ESR in the existing literature (Dong et al., 2022). The second is the impact of ESR. Some scholars have suggested that ESR can promote employees' affective commitment, organizational identification and job satisfaction (Cheema et al., 2020), and that it is also positively correlated with employees' organizational citizenship behaviors and knowledge-sharing behaviors (Farooq et al., 2014). The third is to study the driving factors of ESR. The existing studies have provided evidence that the form of corporate ownership (Hirose and Matsumura, 2022), the prosperity of international trade (Bárcena-Ruiz and Sagasta, 2022), the concept of board governance (Orazalin, 2020), the ability of corporate management and the effectiveness of sustainable development strategies, and the status of corporate human resources, all these conditions can influence corporate environmental social responsibility practices (Sarfraz et al., 2020). Fourth, it focuses on the relationship between environmental regulation and green behavior (Peng et al., 2021; Li and Gao, 2022). Previous studies focused only on the influence of NEPL policy on aspects of green production and innovation (Liu et al., 2021; Wang et al., 2022), or only focus on the impact of corporate ESR on aspects such as corporate competitive performance alone (Dupire and M'Zali, 2018; Battisti et al., 2022), with insufficient attention paid to the relevant links between the two. By summarizing the existing research, we find that there is abundant research on ESR in the existing literature, which lays a good foundation for studying the micro-effects of the NEPL. However, there are still shortcomings in the following aspects: First, in terms of research perspective, most of the previous studies only focused on the impact of the NEPL on corporate tax avoidance and green production, or only focused on the impact of corporate ESR on corporate performance, and paid insufficient attention to the interaction between the two. In addition, the measurement of ESR in existing studies is relatively simple, and the use of one-sided research variables cannot get comprehensive results. Second, in terms of research mechanisms, there is a lack of further testing of the internal channels of policy effects. The existing studies mostly discuss the changes of ESR from the perspective of management system such as corporate governance concept and governance ability, and corporate characteristics such as ownership form and resource status, and there is a lack of further research on the internal channels of its response to policy effects. Finally, the

existing literature only discusses the single impact of the policy and defines the good or bad of the policy with one-sided results. However, the implementation effect of the policy has complexity and time lag, so it is difficult to unilaterally judge the good or bad of the policy to play its real role.

Three possible additions to the current body of literature are offered by this study. First of all, the research on the micro-effects of ESR is enriched from the perspective of the NEPL, and the level of ESR is re-measured, to enrich the existing research results with more comprehensive research variables. Second, it expands the channels through which the NEPL affects the choice of corporate behavior, and explores the policy response behaviors of enterprises facing environmental protection pressure from the perspective of corporate financing and capital efficiency. Finally, this paper discusses the multiple impacts of the NEPL policy from the perspectives of innovation incentives and compliance costs. Considering the time lag of the policy, the effect of the policy is different in the short and long term, and gives a more comprehensive judgment on the effect of the policy.

This essay's remaining sections are organized as follows. The second portion provides an overview of the new law's background and key features, along with a description of the research challenges and pertinent hypotheses. Research techniques and data sources are introduced in the third portion. In the fourth portion, the empirical findings and a discussion of the results are given. In the fifth portion, the empirical results are conducted under a more thorough study. Conclusions and pertinent advice are provided in the sixth portion.

### Policy context and hypothesis development

**Background of the implementation of the NEPL.** The People's Republic of China's ecological protection legislation saw its first change since 1989 when it was ratified on April 24, 2014, and it formally went into effect on January 1, 2015. The newly revised Environmental Protection Law provides a series of powerful measures. Compared with the previous environmental regulation policies, its outstanding features are mainly reflected in the following aspects. At the enterprise level first, with a focus on building an ecological civilization, environmental penalties for enterprises have been increased, increasing the cost of sustainability violations for businesses with daily and continuous penalties for persistent violations of the surrounding regulations. At the governmental level, to strengthen the responsibility of local governments for environmental protection, environmental objectives have been added to the governmental evaluation system by stating unequivocally that governments are in charge of the environmental condition within their regulatory borders. At the level of the individual polluter, the individual polluter is punished by administrative detention, and the direct person in charge of the enterprise who evades supervision is punished by detention, which forces corporate executives to raise their awareness of environmental protection and enhances the deterrent effect of environmental responsibility on enterprises. In addition, the new environmental law also encourages the general public to actively go in for environmental management and inform on all kinds of environmental violations, which expands the participation of the government and social institutions, and raises the public's awareness of environmental protection as well. According to the aforementioned information, the freshly enacted environmental preservation legality is a standard piece of legislation intended to safeguard the environment and limit the actions of specific polluters.

Academics have been quite interested in the NEPL policy since it was passed since it is more coercive and deterrent than past environmental regulations. There is also a lot of discussion about

how it will affect corporate environmental behavior. On the one hand, some studies have affirmed the positive impact of the implementation of the NEPL policy, which is considered to have a positive role in promoting corporate ESR. Currently, most studies focus on corporate environmental governance behavior, technological innovation and research investment (Yu et al., 2021; Xie et al., 2022). Regarding corporate environmental governance, Chen et al. (2020) found that the NEPL policy has a favorable impact on businesses' environmentally responsible actions. In terms of technological innovation, Liu et al. (2021) and Zhu et al. (2022) found that the NEPL policy was crucial in fostering business green innovation, and from the standpoint of the government's environmental consciousness, Fang et al. (2021) discovered that the NEPL policy might greatly boost the number of green patents in highly polluting businesses. On the other hand, various academics presented contrasting conclusions regarding how the NEPL policy's enforcement affected businesses. According to certain academic research, the NEPL's implementation raised the challenges faced by businesses that produce a lot of pollution, increased the costs associated with environmental infractions and output, and increased development uncertainty (Yang et al., 2022; Bravo and Estrada, 2018), such as the study by Cai and Ye (2020), which found that the NEPL prevented businesses from improving their total factor productivity, and the dual objectives of environmental conservation and economic development were not accomplished, and according to Liu et al.'s (2018) research, the new environmental regulations forced Chinese businesses to bear higher operational expenses and increased public pressure, which significantly lowered their capacity to raise capital. In general, NEPL policy has been the subject of extensive investigation. To our knowledge, very few research have systematically examined how the NEPL policy affects corporate ESR. The current study fills this gap by analyzing how the NEPL regulation affects business ESR and serves as a guide for future research and the advocacy of policy.

**Implementation of the NEPL policy and corporate environmental social responsibility.** As a kind of environmental regulation relying on government coercion, the NEPL policy plays an important role in environmental protection by changing the subjective behavioral choices of heavily polluting enterprises through the internalization of negative externalities (Liu et al., 2021). As a binding and flexible policy tool, the policy impact of the NEPL permeates every step of the corporate manufacturing process. This is mainly manifested in the fact that the policy of the NEPL can, by changing the opportunity cost of enterprises' access to loans and financial subsidies, restructure their access to financing on the one hand, and change their risk perception on the other hand, to prompt them to fulfill their environmental social responsibilities.

Overall, the NEPL policy is designed to motivate heavy polluters to fulfill their environmental social responsibilities in terms of both incentives and deterrents. On the one hand, obtaining profits is the main motivation for enterprises to carry out production activities, and if enterprises use their funds to carry out environmental and social activities, it will bring positive externality costs that cannot be internalized by the enterprises, therefore, in the absence of external constraints, enterprises lack the motivation to fulfill their environmental social responsibilities (Yang et al., 2020). In addition, so as to lower the cost of green innovation and motivate businesses to engage in ecologically friendly activities, the new law provides for considerable cash subsidies and government procurement for businesses with exceptional environmental performance, which strengthens the incentives for enterprises to carry out environmentally beneficial

activities, and can motivate enterprises to undertake environmental social responsibility. On the other hand, the main problem inhibiting enterprises from participating in environmental governance is information asymmetry. The benefits for businesses to engage in green production and adopt ESR were not immediately apparent prior to the passing of the new law due to the lack of assessment of the environmental status of enterprises and the oversight of their investment. However, after the promulgation and implementation of the NEPL policy, the government's responsibility for environmental protection has been clarified, and environmental objectives have been incorporated into the government's evaluation system. In addition, the new law also strengthens public supervision, states unequivocally that individuals and organizations have a right to acquire information regarding the environment, and encourages the public to report on enterprises that carry out environmentally polluting activities. Government supervision coupled with public monitoring has a deterrent effect on the environmental pollution behavior of enterprises and can greatly regulate their production and business activities (Berrone et al., 2013; Cheema et al., 2020). Overall, the aforementioned actions have significantly increased the deterrent effect and mandatory force of the new law, applied environmental governance pressure and green transformation motivation to heavy-polluting enterprises, and alleviated the issue of adverse selection and moral risk of the heavy-polluting enterprises in the face of environmental governance. These actions can also encourage the heavily polluting enterprises to be inclined to assume ESR. In conclusion, on the basis of the analysis presented above, we suggest hypothesis 1.

H1: The implementation of the NEPL policy can motivate heavy polluters to assume environmental and social responsibility.

**Regulatory mechanism of the NEPL and corporate environmental social responsibility.** The implementation of the new law is environment-oriented. The political authority represented by the new law can influence the cooperation between enterprises and financial institutions such as banks, and then exert pressure on the environmental behavior of enterprises. Its incentive and punitive policies combine the traits of environmental regulation with the financial sector's resource allocation mechanism. From a corporate behavior standpoint, the implementation of the NEPL policy may not always have incentivising consequences for corporate ESR, and companies may adopt buffer mechanisms to enhance or reduce the actual impact of the policy, with specific behaviors that can be derived from both broadening financing channels and improving capital efficiency.

First, heavy polluters in the context of the NEPL policy can reduce the actual impact of the new law through business credit. For heavy polluters, the NEPL policy increases the uncertainty of the business environment, which makes creditors demand high loan returns as risk compensation when lending, and raises the cost of business financing (Liu et al., 2019). In addition, after the promulgation of the new law, banks are more inclined to clean and environmentally friendly enterprises rather than heavy polluters when approving loan projects, increase the punitive lending interest rate and reduce the upper limit of loan size for heavy polluters. As a result, the NEPL policy's implementation has made it more difficult for major polluters to obtain loan funding. However, commercial credit, as an alternative financing, can achieve an equilibrium between supply and demand. In light of the financial strain caused by the new law's adoption, heavily polluting enterprises may obtain commercial credit financing by delaying delivery or collecting payments in advance to alleviate the debt financing difficulties they face, thus circumventing the

cost increase brought by the NEPL policy (Chai et al., 2022). Second, under the stronger environmental regulation of the NEPL policy, heavy-polluting enterprises will affect the actual effect of the NEPL by improving the efficiency of capital use. Before the NEPL policy strengthened environmental regulation, due to the lack of corresponding regulatory mechanism, the capital cost faced by enterprises was also relatively low, therefore, when carrying out investment activities, enterprises tend to invest in economic activities with high returns but low environmental efficiency, and the probability of choosing green investments with higher production costs is correspondingly lower (Yang et al., 2020). However, with the in-depth implementation of the NEPL policy, the decrease in the availability of funds and the increase in financing costs faced by heavy-polluting enterprises may reduce the probability of heavy-polluting enterprises investing funds in polluting production activities. Based on the above analyses, on the one hand, heavy polluters can alleviate their financing difficulties and reduce their capital needs through commercial credit financing and improving the efficiency of capital use. On the other hand, green development is a general trend, and green projects can obtain more effective capital investment, therefore, enterprises may still undertake ESR by the requirements of the NEPL policy. In this case, the final influence of the NEPL policy on the ESR of heavy-polluting enterprises mainly depends on the trade-off between policy avoidance and the environmental protection investment of heavy-polluting enterprises. Thus, we propose the following hypothesis H2:

H2: The implementation of the NEPL policy may be affected by the moderating effects of corporate business credit and efficiency in the use of capital, but the exact impact is uncertain.

**Mechanism analysis of the NEPL policy and corporate environmental social responsibility.** Under Porter's hypothesis (Porter and Linde, 1995), appropriate environmental regulation can enable enterprises to realize transformation and upgrading through technological innovation, improve input-output efficiency, and partially or completely offset cost increases caused by environmental regulation, in other words, the compensation impact of innovation outweighs the cost of compliance effect (Dorsey-Palmateer and Niu, 2020). Specifically, according to the requirements of the NEPL policy on the enterprise level, forcing enterprises to incorporate environmental protection into enterprise development, the internalization of such external costs can directly influence the investment decisions of enterprises, motivating them to meet the new environmental regulatory thresholds, to achieve the goal of long-term profit maximization, and then take the initiative to increase their investment in technological advancement. In addition, in comparison to the conventional extensive development mode, green production activities can support enterprise transformation and upgrading to increase market competitiveness as well as assist businesses in gaining financial benefits by enhancing production efficiency and mode (Long et al., 2022). In conclusion, engaging in social actions that benefit the environment is a crucial strategy for heavy-polluting businesses to lessen the negative effects of the NEPL policy on their business operations, and the new law's implementation will eventually push businesses to engage in green manufacturing practices and take on environmental and social responsibilities.

However, according to the traditional economic theory of compliance costs (Barbera and McConnell, 1990), the implementation of the NEPL policy may inhibit heavily polluting firms from increasing their investment in technological innovation, i.e., the compliance cost effect outweighs the innovation compensation effect. Specifically, to satisfy the new environmental thresholds, companies must modernize their manufacturing methods to

comply with the environmental criteria established by the NEPL policy, and this upgrading process will make enterprises pay higher environmental protection costs, leading to an increase in the cost of pollution control and environmental compliance costs, thus crowding out some of the productive investment of enterprises, and creating an offsetting effect on the innovative activities and organizational management of enterprises (Shen et al., 2020; Wu et al., 2020). In addition, the internalization of pollution control costs will inevitably constrain technological innovation at the expense of increased production costs, which indirectly hinders the improvement of green productivity of enterprises, and similarly has an inhibitory effect on technological innovation by enterprises. Especially for heavy polluters, the existence of sunk costs makes them reluctant to bear the short-term losses brought by changing the development path, coupled with the fact that the long-standing resource-oriented development model has accumulated significant scale effects and formed path dependence and lock-in effects, making it difficult for heavy polluters to form new production processes (Hao and Liu, 2016; Zhu et al., 2019). Therefore, even if the implementation of the NEPL policy leads to an increase in the current cost of pollution, as long as the cost of environmental regulation is lower than the benefit of its rough development, the management of enterprises following the rational broker assumption will continue the previous polluting development and is unlikely to take the initiative to carry out a green transformation. We suggest the following based on the analysis presented above:

H3a: The NEPL policy produces an innovation compensation effect that is greater than the cost of compliance effect, prompting heavily polluting firms to assume ESR by improving their technological innovation.

H3b: The NEPL policy generates a compliance cost effect that is greater than the innovation compensation effect, forcing heavily polluting firms to avoid ESR by reducing their technological capital investment.

## Research design

**Sample selection and data sources.** Taking into account the data that is available and combined with the research of this paper, the research sample for this paper is A-share listed firms from 2012 to 2020, and the primary data sources are as follows: (1) Data of listed companies obtained from CNRDS the profitability of listed companies, financial statements, enterprise nature, and other data. The subsequent observations were not included in the sample to confirm the validity of the empirical findings: First, business entities that set ST or \*ST throughout the testing period. Second, companies with serious deficiencies in financial indicators or other indicators. Third, data for financial and real estate companies. Fourth, data for companies with gearing ratios greater than 1. To avoid the effect of outliers, bilateral tailing was performed on all control variables at the 1st and 99th quartiles. (2) Data on R&D investment and patent applications of listed companies, executive characteristics of listed companies and political affiliations. The R&D investment situation and green patent application situation of quoted companies were obtained from the CSMAR database; the personal biographies of public company executives and information on executives' government backgrounds were obtained as well, from which the political affiliations of listed company executives' governments were extracted. (3) The information on environmental concerns was personally gathered from corporate annual reports, and the other information came using the CSMAR database. The above data was matched to give the final data for 1228 listed companies.

Moreover, the selection of heavy-polluting enterprises as the research sample in this work was made for two main reasons. On

the one hand, due to the nature of their primary operation, heavily polluting businesses are more dependent on the environment, and at the same time they have a greater destructive effect on the environment, their production and operation activities are more closely linked to the environment, and they have made great contributions to both regional economic development and environmental pollution. Therefore, compared with enterprises in other industry fields, enterprises in heavy-polluting industries are also relatively more affected by environmental regulatory policies (Nekhili et al., 2017; Dhar et al., 2022). On the other hand, compared with other industries, most of the enterprises in the heavy pollution industry belong to heavy industries with strong asset specialization and homogeneous structure, and the existence of sunk costs makes their industrial upgrading more costly (Jiang and Akbar, 2018; Liu et al., 2021), and the new law explicitly requires the enterprises to carry out cleaner production, to enhance environmentally friendly production methods and minimize resource waste have become a must for heavily polluting enterprises to gain profitability and improve competition (Li et al., 2023).

**Identification strategies and variable definitions.** We regard the implementation of the NEPL policy as an exogenous event and employ the continuous differential method to examine how the NEPL policy will influence corporate ESR. It is particularly crucial for this group to evaluate the consequences of the policy since industries that produce large amounts of pollution are more impacted by environmental restrictions like the NEPL. To evaluate the effects of the implementation of the environmental legislation on corporate environmental social responsibility, enterprises in other industries served as the control group while enterprises in the most polluting industry served as the experimental group (Xie et al., 2022).

The subsequent model is established in this paper for evaluating hypothesis one:

$$ECSR_{st} = \beta_0 + \beta_1 DID + \beta_3 X_{st} + \lambda_s + \lambda_c + \lambda_t + \varepsilon_{sct} \quad (1)$$

where  $s$  denotes firm,  $c$  denotes industry, and  $t$  denotes year. The explanatory variables  $ECSR_{st}$  represents the environmental social responsibility behavior of enterprises, and  $DID$  is the core explanatory variable of this paper, which is a grouping dummy variable ( $Treat_c$ ) and time dummy variable ( $Post_t$ ) of the cross-multiplier term.  $X_{st}$  representing a series of control variables, while the model incorporates industry-fixed effects, individual fixed effects and time-fixed effects.  $\varepsilon_{sct}$  represents the disturbance term of the model.

**Explained variables.** Concerning the relevant literature and in the context of this paper, this paper examines the impact of the NEPL policy on the three types of corporate ESR (King and Lenox, 2001; Frondel et al., 2007). Front-end governance ( $FG$ ), measured by the indicator of whether the business creates or employs cutting-edge, environmentally friendly machinery, tools or technologies, indicates that the firm allocates the appropriate assets to purchase environmentally beneficial technologies or research and development if the variable is set at 1. End-of-pipe management ( $EG$ ), as judged by the metric indicating whether or not the company has adopted policies or procedures that minimize emissions of air, wastewater, waste, and greenhouse gases, demonstrates the company's ability to control its pollutant stock. Green behavior of employees ( $EB$ ), is measured by the indicator of whether the company has a green office. Specifically, it refers to the voluntary environmental protection activities carried out by employees, such as waste separation, the use of environmentally friendly substances and the recycling of waste materials.

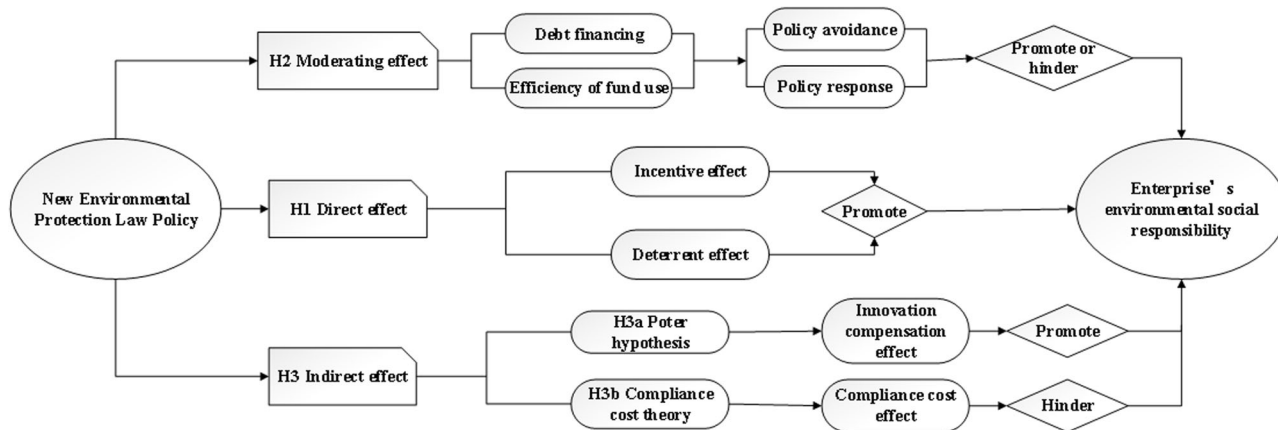


Fig. 1 Diagram of the transmission mechanism.

**Core explanatory variables.** The paper draws on the definitions of heavily polluting industries in two documents, the CSRC's 2012 revision of the Guidelines for the Classification of Listed Companies by Industry, and the 2008 Notice of the Ministry of Ecology and Environment on Printing and Distributing the Administrative Directory of Listed Companies for Environmental Protection Verification Industry. In this paper, 16 subsectors such as oil exploitation and processing, leather manufacturing, and power and heat are defined as heavy-polluting industries, and their codes are B06, B07, B08, B09, C17, C19, C22, C25, C26, C27, C28, C29, C30, C31, C32, and D44 (Huang and Lei, 2021). In addition, 19 other subsectors, including food processing, radio, film and television, culture and art, and animal husbandry, will be classified as non-heavy-polluting industries. The cross-product of and is the core explanatory variable in this paper. DID ( $Treat_c * Post_t$ ) is the grouping dummy variable, in which the listed companies belonging to the heavily polluting industry are taken as the treatment group ( $Treat_c = 1$ ), and the listed companies belonging to the non-heavy polluting industry are taken as the control group ( $Treat_c = 0$ ).  $Post_t$  is a time dummy variable. Since the NEPL takes effect on January 1, 2015, the years 2015 and the following are considered to be the first year that the policy is in force ( $Post_t = 1$ ); otherwise, it is 0.

**Control variables.** The use of control variables can help eliminate errors, and their inclusion or exclusion is of great significance for the study of this paper (Sturman et al., 2022). The selection of control variables should be closely related to the subject and content of the research, and the influence of other error terms should be excluded by controlling its expected relationship with the core variables (Bernerth and Aguinis, 2016). Based on the research in this paper, it can be seen that in the development process of enterprises, factors such as scale, profitability and debt are closely related to the production and development of enterprises. These factors can be used as important indicators to measure the performance of enterprises, and are closely related to their resource investment in the field of environmental social responsibility. Therefore, we consider potential control variables such as corporate profitability and general characteristics to assess how the new environmental law affects ESR behavior beyond the impact of profitability, maximizing statistical power and providing the most explicable results. Based on this, this paper refers to the selection methods of Lin et al. (2014) and Liu et al. (2019), and finally selects the following control variables. Company size (*Size*): the size of the business is determined quantitatively using the annual total assets' natural pair. Cash flow ratio (*Cashflow*): total assets divided by cash flow from operating operations.

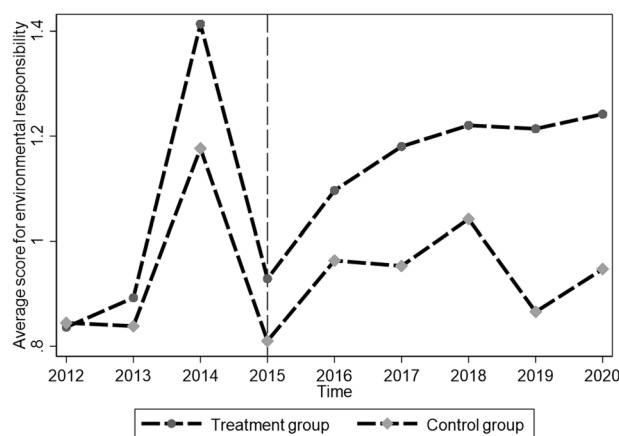


Fig. 2 Corporate environmental responsibility score.

Return on equity (*Roe*): net profit divided by the average balance of shareholders' equity. Net profit rate on total assets (*Roa*): net profit divided by the average balance of total assets. Turnover ratio of net assets (*Ato*): sales revenue divided by the average of total net assets at the beginning and end of the period. Asset-liability ratio (*Lev*): total liabilities at year-end divided by total assets at year-end. Revenue growth rate (*Growth*): ratio of the current year's operating revenue to the previous year's operating revenue minus 1. Nature of the enterprise (*Soe*): for state-owned businesses, the ownership nature is 1, and 0 for non-state-owned businesses (King and Lenox, 2002). Furthermore, both control time and industry-fixed effects are in existence (Fig. 1).

The setting method of this paper not only describes the size of the treatment group affected by the policy but also excludes the case that non-heavy-polluting enterprises are defined as the treatment group, which can measure the impact of the NEPL policy. Figure 2 plots the corporate environmental responsibility scores of the treatment and control groups since 2012. As shown in the figure, the difference between the environmental responsibility scores of the treatment group and the control group was small but fluctuating before 2015, whereas after 2015, the environmental responsibility scores of the treatment group improved significantly, showing a steady upward trend and an increasing gap with the control group's scores after 2016. This affirms the positive effect of the implementation of the NEPL policy. Before 2015, the NEPL policy had not yet come into effect, and there was uncertainty about the behavior of enterprises in assuming ESR. It is worth noting that there was a significant

**Table 1 NEPL and corporate environmental social responsibility behavior.**

Variables	(1) FG	(2) EG	(3) EB	(4) FG	(5) EG	(6) EB
DID	-0.007 (-0.274)	0.093*** (9.071)	0.050* (1.950)	0.016 (0.612)	0.093*** (8.563)	0.020** (2.230)
Constant	0.479*** (60.112)	0.127*** (41.967)	0.362*** (48.150)	-1.717*** (-15.633)	-0.029 (-0.659)	0.288*** (7.890)
Control variables	No	No	No	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7335	7335	7335	6698	6698	6698
R-squared	0.103	0.743	0.151	0.173	0.746	0.898
F	0.0750	82.28	3.802	65.76	13.03	6468

Notes: Robust t-statistics in parentheses. \*\*\*, \*\*, and \* represent the significance levels at 1%, 5%, and 10%, respectively. "Yes" means that relevant variables and fixed effects are added to the model, and "No" means that no relevant variables and fixed effects are added to the model.

increase in the environmental responsibility scores of enterprises in 2014, which may be due to the impact of the implementation of the Action Plan for the Prevention and Control of Air Pollution. Following the adoption of the NEPL policy in 2015, due to severe environmental rules, the development of significantly polluting firms has increased in the process of adapting to the NEPL, resulting in a consistent upward trend in the treatment group’s level of ESR. As for the control group enterprises, which are not affected by external environmental pressure, the overall performance in terms of pollution emission is poor and shows an uncertain trend.

**Empirical analyses**

**Benchmark regression.** Table 1 lists the estimation outcomes of the model, with columns (1) through (3) representing the outcomes when control variables are not included, controlling only for industry and time-fixed effects, and columns (4) through (6) representing the outcomes when control variables are included and all fixed effects are taken into account. The findings indicate that the application of the NEPL regulation has varying effects on several environmental social responsibility behaviors. in which, consistent with Shen et al. (2020) study, the enactment of the NEPL policy incentivizes end-of-pipe treatment and employee green office for heavy polluters, and the probability of heavy polluters carrying out end-of-pipe treatment and green office increases by 9.3% and 2%, respectively, with the increase in the intensity of the policy that has significant economic significance. However, unlike studies that emphasize front-end governance pollution prevention (Lee and Rhee, 2005; Sun et al., 2019), in this paper, whether or not control variables are included, the NEPL policy’s impact on heavy-polluting enterprises front-end governance is not appreciably significant, and it can be explained in terms of the following aspects: first, the NEPL policy on the end-of-pipe governance of heavy-polluting enterprises and green offices are orientation. It is clearly stipulated in the NEPL policy that the government should increase the financial investment in pollution control and reduce the generation of pollutants from the production process. At the same time, the new law advocates the introduction of clean production technology, waste gas pollution treatment, and utilization technology, and increases the control of their stock of pollutants. Second, the high-cost front-end governance model has weakened the investment tendency of heavily polluting enterprises. The front-end treatment method requires heavy-polluting enterprises to eliminate production equipment that causes serious pollutant emissions, and encourages them to give priority to low-energy and high-efficiency facilities and equipment, which means that pollution-

focused enterprises need to increase capital investment in machinery and equipment, and enterprises have invested more costs than controlling the stock of pollutants. Therefore, heavy-polluting enterprises tend to choose the end treatment model with lower cost and carry out green office. In conclusion, hypothesis 1 is confirmed, showing that the NEPL policy’s enforcement typically enhances the ESR behavior of heavily polluting firms, but the effects of different treatment methods are somewhat different.

**Robustness tests**

*Parallel trend tests and policy time uniqueness.* The use of double-difference policy evaluation presupposes that the parallel trend assumption needs to be satisfied to hold as well as the certainty of policy timing. Therefore, this study runs the following tests to make sure that the parallel trend assumption and the uniqueness of the policy time point are valid: (1) We define the sample of the treatment group as pre\_1-pre\_3 prior to the new law’s launch, then successively designate the sample of the treatment group following the new law’s implementation as post\_1-post\_5, and in light of multicollinearity, we remove the policy time point’s prior phase pre\_1 (Yin et al., 2011). The findings reveal that the regression results in the years before the policy’s launch are not statistically significant, demonstrating that the model adheres to the common trend assumption. In addition, according to the results of dynamic effects, the NEPL policy’s influence on front-end governance is little in the majority of years after its implementation, whereas the dynamic impact on end governance is more important and has a steady long-term impact. Moreover, the new law lags somewhat and only has a little effect on green offices. (2) Only the samples taken before the start of the policy are kept, and the start time of the policy is advanced by 2–3 years, respectively, and then Formula 1 is reestimated. It is anticipated that the implementation of the NEPL policy won’t have a substantial impact on the various ESR behaviors of heavy-polluting firms because the start time of the policy at this point is “false.” The regression’s findings largely matched those predicted. Before the implementation of the policy, the three different types of ESR behaviors of firms were not significantly impacted by the NEPL policy, so it is correct to use 2015 as the start of the policy. Specific regression results are detailed in Figures (a)–(c) (see the results of parallel trend test in Appendix) and Table 2 in the Annex.

*Placebo test.* Two methods of placebo testing are used in this article. The first is to use non-environmental social responsibility as the explanatory variable. A three-level indicator of other

**Table 2 Testing the effect of policy regulation.**

Variables	(2) Business credit regulation effect			(5) Adjustment effect of fund use efficiency		
	(1)	(2)	(3)	(4)	(5)	(6)
	FG	EG	EB	FG	EG	EB
DID	0.026 (0.952)	0.087*** (7.524)	0.019** (2.209)	-0.020 (-1.214)	0.064*** (4.962)	0.026** (2.474)
Inter1	0.010 (1.371)	0.011*** (3.587)	0.000 (0.196)			
TC	0.003 (1.288)	-0.001* (-1.790)	0.003*** (5.358)			
Inter2				0.031 (1.578)	0.063*** (4.140)	-0.014 (-1.109)
Inveff				1.148*** (117.844)	0.010 (1.342)	0.022*** (3.596)
Constant	-1.711*** (-13.879)	-0.055 (-1.060)	0.436*** (11.118)	-0.966*** (-16.756)	0.000 (0.010)	0.342*** (9.290)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6054	6054	6054	6692	6692	6692
R-squared	0.184	0.745	0.906	0.779	0.747	0.900
F	52.11	10.78	4708	1835	12.74	4801

Notes: Robust t-statistics in parentheses. \*\*\*, \*\*, and \* represent the significance levels at 1%, 5%, and 10%, respectively. The meanings of "Yes" and "No" are as described above.

socially responsible behaviors, such as “charity, volunteer activities, and social controversies” was selected as the explanatory variable and analyzed, with the expectation that these socially responsible behaviors would not be affected by the new environmental policy. The other is to divide the control and treatment groups at random. Under the premise of keeping the policy duration unchanged, industries with the same number of heavily polluting industries were randomly selected from the sample as the random treatment group, and the model was used to randomly simulate the virtual policy effect. The findings demonstrate that the NEPL policy has little impact on the socially responsible actions of highly polluting companies that are unrelated to the environment. The vast majority of p-values are more than 0.1 and inconsequential at the 10% level when it comes to the significance of the random findings, whereas the real estimates are empirically significant. Specific regression results are detailed in Exhibit 3.

*Sample selection issues.* The Heckman (1979) selection model is employed to determine if there was sample selectivity bias caused by the non-random behavior of the primary polluter. The probit model is employed in the model’s first phase to estimate the likelihood that a listed firm will be observed or not and calculate the IMR as well. The IMR is then incorporated into the model in the second phase in order to compensate for sample selectivity bias. Compared to the initial findings of the regression results, the results were still significant after the addition of IMR to eliminate sample selective bias, but the economic significance decreased. Specifically, the new environmental law policy in the Heckman selection model reduces the probability of enterprises participating in end-management by 0.95% and the likelihood of implementing green office for employees by 0.24%. Among them, the probability of enterprises participating in front-end governance is still not significant. In summary, estimation bias is not significantly influenced by sample selection bias. The regression results are shown in Exhibit 4.

*Exclusion of other policies.* Other policy considerations are primarily eliminated from three aspects, further excluding the influence of other environmental regulations passed during the identical period. First, how the Green Credit Guidelines, released

in 2012, have affected the environmental social responsibility of large polluters. The Notice on the Issuance of Green’s Credit instructions, which was published in 2012 by the former China Banking Regulatory Commission, has some bearing on the environmental and social responsibility practices of heavily polluting businesses and effectively limits their behavior through financial institutions’ loans to them. Through the use of dummy variables for years after 2012, the Green Credit Directive’s impact is disregarded in this study. Besides, the effect of experimental carbon-trading regulations on the environmental and social accountability of highly polluting companies. To encourage regional heavy polluters to take on environmental and social obligations, China has formally started carbon emission pricing pilot programs in Beijing, Shanghai, Guangdong, Fujian, and other eight regions since 2013. By excluding the sample of provinces that participate in the ETS pilot program for carbon emission trading, this article reduces the impact of this policy. Third, how the green finance reform pilot zone affects the environmental and social conduct of corporations. China established nine green finance reform and innovation pilot zones in six provinces, including Zhejiang, Guangdong, and Jiangxi, in September 2016. It is certain that the green finance reform development trend in pilot zones will differ from that in other regions. This study eliminates the provinces that established green finance reform pilot zones, hence reducing the impact of this program. Regression results show that the NEPL always has a significant positive impact on the end treatment of highly polluting enterprises but has no discernible effect on the front-end treatment and the green office of employees, which is the same as the baseline regression results. This finding indicates that the conclusions of this paper will not be interfered with by the policy environment of the same period, thus proving again that the conclusions of this paper are robust. The regression results are shown in Exhibit 5.

**Tests of policy adjustment effects.** When the NEPL policy plays a role, the response of enterprises is not the only one. In addition to assuming environmental and social responsibilities by the policy requirements, they may also adjust the actual impact of the



policy with some buffer or promotion mechanisms. Referring to the research of Liu et al. (2019) and Chai et al. (2022), this study contends that commercial credit finance and corporate capital use efficiency will play a role in regulating heavy-polluting firms' ESR. To examine the regulatory effects of these two strategies on the environmental social responsibility of heavy-polluting firms, this article builds the following model to test the above premise.

$$ECSR_{st} = \pi_0 + \pi_1 DID + \pi_2 TC_{st} + \pi_3 DID * TC_{st} + \theta X_{st} + \lambda_s + \lambda_c + \lambda_t + \varepsilon_{sct} \tag{2}$$

$$ECSR_{st} = \rho_0 + \rho_1 DID + \rho_2 Inveff_{st} + \rho_3 DID * Inveff_{st} + \theta X_{st} + \lambda_s + \lambda_c + \lambda_t + \varepsilon_{sct} \tag{3}$$

where,  $TC_{st}$  represents the scale of enterprise commercial credit financing, using the sum of accounts payable, notes payable and accounts received in advance measurement.  $Inter1$  represents the interaction between  $DID$  and  $TC_{st}$ , and measures the regulating effect of  $TC_{st}$ .  $Inveff_{st}$  represents the enterprise capital use efficiency, reflecting the turnover speed of all assets from input to output during the operation period. The higher the enterprise capital use efficiency, the stronger the operation capacity of the enterprise's overall assets.  $Inter2$  represents the interaction term between  $DID$  and  $Inveff_{st}$ , and measures the regulating effect of  $Inveff_{st}$ . The remaining factors are congruent with what has been stated before.

Table 2 reports the results of the moderating effects of the policy. The results show that an increase in the scale of commercial credit financing does not reduce the probability of undertaking environmental and social responsibility for heavy pollution, and similarly, firms with more efficient use of funds are more inclined to increase their level of ESR. In columns (1)–(3), the likelihood of carrying out end-of-pipe treatment increases with an enterprise's level of commercial credit finance, which indicates that between responsibility avoidance and responsibility assumption, enterprises did not use commercial credit financing means to avoid environmental responsibility behavior. In terms of the moderating effect of capital use efficiency, columns (4)–(6) show that enterprises with higher capital turnover do not reduce the level of end-of-pipe treatment, which indicates that even if enterprises improve their capital use efficiency by accelerating capital turnover, they do not reduce their level of social responsibility. The above regression results suggest that even though heavily polluting firms can attenuate the economic impact of the new law by using less capital through commercial credit financing and increasing the efficiency of capital use by accelerating capital turnover, this does not reduce their level of environmental and social responsibility. These findings are consistent with existing research (Cheema et al., 2020). This suggests that for firms, the penalties and incentive deterrence from the NEPL policy outweigh the short-term gains from avoiding social responsibility. Specifically, avoiding ESR can only bring short-term gains, and firms are more inclined to seek longer-term development than the longer-term development that comes from implementing a green transformation, thus choosing to undertake ESR (Liu et al., 2021). In addition, the moderating effects of commercial finance and capital usage efficiency are not economically significant for front-end governance and green office, which may be due to the following reasons: First, compared with front-end governance and green office, firms are more experienced in end-of-pipe governance and thus more effective, and it is easier for them to form a path dependency on the end-of-pipe governance approach. The higher the level of commercial credit financing, the more enterprises seek to maximize cost-

effectiveness and target availability, and thus are more inclined to choose the end-of-pipe treatment that maximizes efficiency. Second, the more efficient the use of funds, the higher the level of asset management. As carrying out front-end governance and the green office is inefficient and the input-to-benefit ratio is lower than that of the end-end governance model, enterprises with more efficient use of funds will not increase their investment in front-end governance and green office. Overall, enterprises are more willing to pursue long-term development in the face of the trade-off between the short-term benefits of avoiding taking environmental responsibility and the long-term benefits brought by green transformation, and at the same time, there is no significant moderating effect of both expanding commercial credit financing and improving the efficiency of capital use on the policy effect of front-end governance and green office. In summary, hypothesis 2 is tested.

### Further analyses

**Mechanism testing.** Due to Porter's hypothesis and the compliance cost effect, there is uncertainty about the impact of NEPL policy implementation on firms' technological capital investment and green technology innovation. In addition, given the limited evidence provided by current research on the impact mechanisms of the NEPL policy, this study specifically assesses whether the implementation of the NEPL policy can stimulate technological innovation incentives for firms to promote or force firms to take on ESR, taking into account this research gap and in conjunction with Hypothesis 3 presented above. The following section focuses on testing whether such a channeling effect exists.

Technological innovation can be divided into technology introduction and independent innovation, following the examination of the mechanism in the preceding section, it can be seen that heavily polluting enterprises can improve the level of technological innovation in the short term by purchasing advanced pollution control equipment or carrying out independent innovation, to cope with the regulatory pressure of the NEPL. To confirm the presence of the new law's incentive effect on corporate technological innovation, the study of Li and Gao (2022) was used, we use the logarithm of the amount of enterprises' capital investment plus one ( $RDIM$ ) as the indicator of technology introduction, and the logarithm of the total number of patents applications plus one ( $GPA$ ) as the indicator of independent innovation, and carry out a mechanistic test of the incentive effect of technological innovation. In addition, this paper also refers to the method of Dinkelman (2011) to test the mechanism by constructing the following mediation effect model:

$$RDIM_{st} = \alpha_0 + \alpha_1 DID + \theta X_{st} + \lambda_s + \lambda_c + \lambda_t + \varepsilon_{sct} \tag{4}$$

$$ECSR_{st} = \psi_0 + \psi_1 RDIM_{st} + \theta X_{st} + \lambda_s + \lambda_c + \lambda_t + \varepsilon_{sct} \tag{5}$$

$$GPA_{st} = \alpha_0 + \alpha_1 DID + \theta X_{st} + \lambda_s + \lambda_c + \lambda_t + \varepsilon_{sct} \tag{6}$$

$$ECSR_{st} = \psi_0 + \psi_1 GPA_{st} + \theta X_{st} + \lambda_s + \lambda_c + \lambda_t + \varepsilon_{sft} \tag{7}$$

Among them,  $RDIM$  is the amount of financial input, which represents the indicator of technology introduction, and  $GPA$  is the green patent application, which represents the indicator of technological independent innovation. The remaining variables are consistent with the above.

Table 3 displays the results of the regression. The coefficient of  $DID$  on  $RDIM$  can be determined to be significantly negative, and the coefficient on  $GPA$  is similarly negative but not significant, which indicates that the implementation of the NEPL policy does not promote corporate ESR by prompting firms to increase technological capital investment, on the contrary, the implementation of the NEPL policy plays a certain hindering effect on the

**Table 3 Test of incentive effects of technological innovation.**

Variables	(1) (2) (3) (4)				(5) (6) (7) (8)			
	Technology introduction (RDIM)				Independent innovation (GPA)			
	RDIM	FG	EG	EB	GPA	FG	EG	EB
DID	-0.240** (-2.531)	0.061** (2.096)	0.101*** (8.060)	0.028*** (2.954)	-0.043 (-1.523)	0.018 (0.665)	0.093*** (8.573)	0.020** (2.287)
RDIM		0.008** (2.296)	-0.003* (-1.671)	0.007*** (6.341)				
GPA						0.030*** (4.344)	0.001 (0.385)	0.005** (2.153)
Constant	-4.816*** (-2.605)	-1.800*** (-14.503)	-0.050 (-0.936)	0.382*** (9.472)	-0.918* (-1.763)	-1.607*** (-14.101)	-0.012 (-0.253)	0.348*** (9.241)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5491	5647	5647	5647	6554	6692	6692	6692
R-squared	0.719	0.171	0.742	0.901	0.791	0.176	0.746	0.900
F	20.54	45.67	9.720	4461	3.713	55.29	10.85	5274

Notes: Robust t-statistics in parentheses. \*\*\*, \*\*, and \* represent the significance levels at 1%, 5%, and 10%, respectively. The meanings of "Yes" and "No" are as described above.

behavior of firms' technological capital investment, which is consistent with the studies of Cai and Ye (2020) and Tang et al. (2020). The reasons for this may be that, first, the NEPL policy has been implemented for a relatively short period, and its impacts on firms other than pollution control may not have been fully revealed yet. Second, numerous control elements can have a substantial impact on company innovation, such as capital structure, governance structure, and incentive scheme. However, after the new legislation is implemented, firms do not make the effort to adjust these elements, resulting in these factors affecting company innovation and being unable to respond to the NEPL policy's requirements. As a result, it cannot provide a bigger stimulus effect on enterprise innovation investment, and the NEPL policy's regulatory role cannot rapidly and effectively affect the introduction of enterprise technology. In addition, the NEPL policy does not have a significant impact on green patent applications, which may be because the new law mainly focuses on green and low-carbon development, i.e., green industries, production process projects, etc., and does not pay enough attention to independent innovation, such as invention patents. Meanwhile, independent innovation also requires a certain amount of time accumulation and capital investment, which is difficult for enterprises to realize in a short period. Furthermore, RDIM and GPA have significant effects on all three types of corporate ESR behaviors, and there is an obvious mediating effect, but due to the NEPL policy's inhibitory effect on technological innovation, its incentive effect on heavy-polluting enterprises' technological innovation is not apparent in the sample interval. Overall, the NEPL policy's implementation has a greater follow-cost effect on enterprise technological innovation than an incentive effect, and in short-term periods, enterprises tend to deal with the law's economic effects by avoiding the cost increases brought on by technological innovation, which makes the innovation compensation effect take a longer period to be manifested. Therefore, at this stage, to incentivise enterprises to carry out technological innovation, policymakers should take into account the actual situation of enterprises to make policy improvements. In summary, hypothesis 3b is verified.

**Heterogeneity analysis**

*Regulation intensity heterogeneity.* The NEPL is punitive and mandatory, which mainly focuses on the power of the government rather than responsibility, and has a certain deterrent effect on

heavily polluting enterprises to fulfill their environmental and social responsibilities. Indeed, strict law enforcement is a requirement for efficient environmental policy implementation. If the punishment for the pollution behavior of enterprises is relatively light, the cost caused by pollution of enterprises will still be borne by external entities, and businesses will be less motivated to fulfill their social and environmental obligations as a result. Consequently, the strength of law enforcement has an important impact on the implementation effect of the NEPL policy. Based on this, this article explores the various effects of the NEPL policy on the environmental social responsibility of heavy-polluting firms in locations with high and low environmental regulation intensity.

Table 4 displays the expected results for various environmental regulation levels, among which (1)–(3) is listed as the estimated results of weak environmental regulation intensity, (4)–(6) is listed as the estimated results of moderate environmental regulation intensity, and columns (7)–(9) are the estimated results of strong environmental regulation intensity. The results show that the intensity of environmental regulation has an inverted U-shaped change on the probability of enterprises undertaking environmental social responsibility. This is consistent with Lankoski's (2000) conclusion that there is an inverted U-shaped relationship between environmental performance and corporate efficiency. To be specific, at the level of moderate intensity environmental regulation, the new law has an incentive effect on enterprises to carry out end governance and employees' green office, and the probability of carrying out end governance is higher. This indicates that enterprises' commitment to environmental social responsibility and the extent of environmental regulation are positively associated within a certain limit. Under the pressure of regulation, businesses are more likely to engage in socially beneficial environmental activities when more stringent environmental regulations are established. However, when the pressure of environmental regulation exceeds a certain limit, the level of environmental regulation is negatively correlated with the undertaking of environmental social responsibility by enterprises. The above research findings are instructive for the effective implementation of the NEPL policy. In the process of implementation, the new law should be strict and soft, which should not only give play to the "penalty effect" of the policy but also not be too strict to affect the development of enterprises.

*Management level heterogeneity.* According to the senior echelon theory, the personal characteristics of corporate executives have

**Table 4 Regulation intensity heterogeneity.**

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Weak environmental regulation			Medium environmental regulation			Strong environmental regulation		
	FG	EG	EB	FG	EG	EB	FG	EG	EB
DID	0.037 (0.769)	0.093*** (4.854)	0.019 (1.151)	-0.035 (-0.756)	0.119*** (6.098)	0.030** (2.092)	0.055 (1.206)	0.063*** (3.559)	0.012 (0.780)
Constant	-1.288*** (-7.000)	-0.030 (-0.405)	0.252*** (3.926)	-2.055*** (-10.334)	-0.043 (-0.506)	0.217*** (3.450)	-1.723*** (-8.097)	-0.000 (-0.002)	0.438*** (6.299)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2158	2158	2158	2293	2293	2293	2245	2245	2245
R-squared	0.220	0.721	0.899	0.223	0.716	0.916	0.141	0.800	0.886
F	16.92	3.795	2125	28.64	6.896	2656	17.72	3.368	1740

Notes: Robust t-statistics in parentheses. \*\*\* and \*\* represent the significance levels at 1% and 5%, respectively. The meanings of "Yes" and "No" are as described above.

**Table 5 Heterogeneity of executive education.**

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Non-doctoral degree enterprise			Doctor degree or above enterprise		
	FG	EG	EB	FG	EG	EB
DID	-0.018 (-0.296)	0.113*** (3.951)	0.009 (0.421)	0.028 (0.949)	0.092*** (7.933)	0.022** (2.231)
Constant	-1.349*** (-5.274)	0.134 (1.122)	0.204** (2.382)	-1.798*** (-14.483)	-0.052 (-1.072)	0.318*** (7.773)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1239	1239	1239	5459	5459	5459
R-squared	0.206	0.714	0.899	0.174	0.757	0.900
F	7.882	3.591	1107	56.52	12.33	5422

Notes: Robust t-statistics in parentheses. \*\*\* and \*\* represent the significance levels at 1% and 5%, respectively. The meanings of "Yes" and "No" are as described above.

an important impact on corporate strategic decision-making. Directors with academic backgrounds can enhance the competitive advantage of enterprises through knowledge spillover (Audretsch and Lehmann, 2006; Chen et al., 2015). In addition, the level of corporate governance plays a significant role in determining whether environmental social responsibility is met, and the educational background or academic experience of corporate leaders affects their understanding of the social performance of highly polluting businesses (Francis et al., 2015). The NEPL’s implementation is one of the most comprehensive governance approaches in history, and the success of this strategy primarily hinges on how well micro-subjects comprehend and abide by the policy. Generally speaking, educational background reflects competence to some extent. The higher the educational level corporate executives receive, the more likely they are to judge policy direction based on rigorous professional knowledge, and the more likely they are to undertake environmental and social responsibilities.

Table 5 shows the heterogeneity analysis results of senior executives’ educational backgrounds. Since most of the executives in enterprises have a doctor’s degree, the differences in educational background are differentiated according to the doctor’s degree. In the table, (1)–(3) are listed as senior executives with a doctor’s degree or less, and (4)–(6) are listed as senior officials with a doctor’s degree or above. The results indicate that the NEPL has no discernible impact on front-end governance and green office in non-doctoral executive firms. However, in

executive enterprises with a doctorate or higher, the NEPL has a substantial incentive effect on enterprises to carry out terminal governance and green office governance, and green office governance is particularly impacted. Specifically, the level of environmental and social responsibility undertaken by enterprises varies with the educational background of senior executives. The differences among different groups are mainly reflected in the end-management and green office. Compared with non-doctoral executive enterprises, the probability of green office development is higher in executive enterprises with a doctoral degree or above. The fact that businesses with stronger educational backgrounds may help to explain this may be more sensitive to policy orientation and hence more likely to adhere to policy standards intended to increase political support and improve corporate reputation. As a result, following the adoption of the new environmental legislation policy, firms with highly educated executive backgrounds respond more strongly to the regulation and are more likely to engage in environmentally positive social activities. In conclusion, the above results reflect the differences in environmental awareness of companies under different educational backgrounds.

*Firm-level heterogeneity.* Ownership, as the basis of corporate governance, has an important impact on firms’ environmental behavior, and heavily polluting firms with different property rights properties may have different sensitivities to environmental regulation (Yu et al., 2017; Dong et al., 2022). Table 6 reports the

**Table 6 Enterprise-level heterogeneity.**

Variables	(1) State-owned enterprise			(5) Non-state-owned enterprise		
	(1)	(2)	(3)	(4)	(5)	(6)
	FG	EG	EB	FG	EG	EB
DID	0.019 (0.571)	0.057*** (4.086)	0.010 (0.898)	-0.004 (-0.085)	0.148*** (8.856)	0.026* (1.779)
Constant	-1.728*** (-11.530)	0.076 (1.229)	0.343*** (7.298)	-1.889*** (-10.991)	-0.080 (-1.186)	0.307*** (5.173)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3658	3658	3658	3034	3034	3034
R-squared	0.208	0.754	0.907	0.172	0.756	0.897
F	46.56	6.342	3858	28.47	13.52	2832

Notes: Robust t-statistics in parentheses. \*\*\* and \* represent the significance levels at 1% and 10%, respectively. The meanings of "Yes" and "No" are as described above.

test results of property rights differences at the enterprise level. Columns (1)–(3) represent the test results of state-owned enterprises, and the coefficient in column (2) is significantly positive. Columns (4)–(5) show the test results of non-state-owned enterprises, and the coefficients of (5)–(6) are significantly positive. As can be shown, the new law simply increases the likelihood that state-owned businesses will perform end governance; it has no appreciable effect on front-end governance or green office. However, the new law has a substantial incentive effect on businesses in non-state-owned enterprises to implement end-management and green office, and the likelihood of engaging in end-management is higher. The reasons for the above results may lie in two aspects. To be specific, state-owned enterprises have a closer relationship with the government first, and their strong bargaining power can reduce the deterrent effect of the new law on them. Compared with state-owned enterprises, non-state-owned enterprises are at a disadvantage in market competition, so they will be subject to stricter environmental review and face stricter law enforcement (Chen et al., 2015). Second, rising environmental uncertainty may aggravate business risks and liquidity risks of enterprises, while non-state-owned enterprises are relatively weak in risk resistance. Therefore, compared with non-state-owned enterprises, they are more inclined to raise public attention by undertaking environmental and social responsibilities, to avoid the risk of punishment. It can be seen that the NEPL policy has stronger environmental regulations on non-state-owned heavy polluters.

**Conclusions and policy recommendations**

In this paper, the relevant data of China’s heavily polluting listed companies from 2012 to 2020 were used to investigate the changes in the level of environmental social responsibility of heavily polluting enterprises after the implementation of the NEPL policy. The results show that the implementation of the NEPL policy mainly improves the level of ESR of heavily polluting enterprises by improving the end treatment and the green office level of employees, but has little effect on how patients behave during treatment. Our empirical results show that enterprise financing scale and fund use efficiency have a certain moderating effect on heavy-polluting enterprises to undertake environmental social responsibility, and the punishment and awe brought by the NEPL are higher than the short-term benefits brought by avoiding social responsibility. In addition, the mechanism analysis shows that the implementation of the new law has a short-term crowding-out effect on the technological innovation of heavy-polluting enterprises. Finally, we find that in terms of heterogeneity analysis, the

impact of environmental regulation intensity on enterprises’ environmental social responsibility has an inverted U-shaped change. The higher the executive education level and non-state-owned enterprises are, the more inclined they are to undertake environmental and social responsibility.

The results of this study possess significant policy and managerial ramifications. First of all, these results are useful for policymakers to assess the overall effectiveness of the policy environment. On the whole, the NEPL policy can improve the environmental social responsibility of heavy-polluting enterprises, but it will also be regulated by commercial credit financing and capital use efficiency. Enterprises can avoid the impact of environmental regulations by reducing commercial credit financing and improving capital use efficiency. Therefore, policymakers should enhance the evaluation system and environmental information disclosure system of the NEPL policy, which is helpful to improve the ability of the NEPL policy to internalize pollution costs, strengthen the guiding role of the NEPL policy, and accelerate the overall improvement of environmental governance. Second, the study’s findings help businesses increase their understanding of environmental responsibility and give internal environmental issues in the production process more attention from the standpoint of business development. If enterprises want to pursue sustainable development when facing stricter environmental laws and regulations, they must increase their understanding and level of environmental governance, strengthen their cooperation with the government, coordinate the management of environmental problems, and invest resources into the sustainable development of main business and environmental protection investment. Finally, based on the inverted U-shaped relationship between the intensity of environmental regulations and enterprises’ commitment to environmental society, the government should pay attention to the regulatory limits when the new environmental protection law is put into effect. It should not only severely crack down on the environmental pollution behaviors of enterprises, but also give enterprises full autonomy, in order not to be too strict and even affect the normal production activities of enterprises.

While this study is consistent with the available evidence on the causation between environmental legislation and environmental social responsibility, it also has some limitations to optimize in the future. Above all, it is challenging to completely rule out the influence of all subsequent events, which might possess a conspicuous impact on how seriously businesses take their commitment to social and environmental responsibility. Moreover, there is a lack of endogenous treatment of internal channels in the aspect of theoretical modeling. Finally, the factors considered in this study are difficult to exhaust, and there may be other factors

that can reveal the influence of the NEPL policy on the environmental social responsibility of heavy-polluting enterprises; future studies may deserve in-depth exploration from this direction.

### Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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## Author contributions

GW: conceptualization and methodology. MS: formal analysis, validation, and writing—original draft. YF: investigation, resources, and writing—review and editing.

## Competing interests

The authors declare no competing interests.

## Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

## Informed consent

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## Additional information

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