

Article

“A Double-Edged Sword” for Sustainability: How Environmental Administrative Punishments Impact Corporate Employment

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Abstract

Environmental administrative punishments are widely employed to deter corporate environmental misconduct while serving the overarching objective of sustainable development, yet their broader social impacts remain understudied. Using data on Shanghai- and Shenzhen-listed non-financial firms from 2007 to 2022 for examination, this study finds that such environmental administrative punishments reduce corporate employment growth by exacerbating firms' internal and external financial constraints. Instrumental variable, propensity score matching, and DID approaches are used to address endogeneity concerns in this paper. Cross-sectional results indicate that the negative effect is mitigated by state ownership and local labor protection, but amplified in heavily polluting industries and by a high level of corporate internationalization. Further, although penalized firms exhibit lower employment growth, they optimize human capital structure to enhance green innovation, capturing the double-edged sword effect of environmental administrative punishments. These findings reveal the economic and social consequences of environmental punishments and provide policy implications for advancing effective environmental regulations and high-quality employment development.

Keywords: environmental administrative punishments; employment growth; financial constraints; human capital structure; green innovation; sustainability



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1. Introduction

The Central Economic Work Conference in December 2024 made “accelerating the comprehensive green transformation of economic and social development” a key task for the Chinese government in 2025. As countries across the globe pay increasing attention to environmental issues, the Chinese government faces the dual challenge of stringent environmental enforcement and “high-quality full employment.” The 2024 Central Economic Work Conference has identified both stabilizing the labor market and pursuing green targets as urgent policy priorities. Therefore, understanding whether environmental administrative punishments, a key tool for ecological protection, unintentionally trigger labor market shocks is crucial for achieving a balanced “win-win” between environmental goals and social stability.

Environmental administrative punishments refer to the administrative sanctions imposed by governmental authorities upon enterprises, institutions, or other producers and operators that engage in environmental violations, in conformity with the relevant laws and regulations on environmental protection. The principal forms of punishment encompass fines, orders to suspend production for rectification, temporary suspension or revocation of licenses, and legal administrative detention of responsible persons.

Environmental administrative punishments are not uncommon across the global. In China, Zijin Mining Group triggered a severe environmental pollution incident at its Zijinshan Copper Mine in July 2010, and was imposed a fine of 30 million yuan by environmental authorities in 2013 over this accident. Similar law enforcements have also been observed across Europe and the United States. Back in 2021, the European Commission found that Volkswagen and BMW had colluded to cut corners on diesel vehicle exhaust emission purification performance, imposing a combined fine of EUR 875.1 million on the two corporations. In 2026, a coking facility owned by DTE Energy in the United States was imposed a civil penalty of USD 100 million for violating review provisions under the Clean Air Act and discharging sulfur dioxide in excessive concentrations over an extended period.

These real-world cases have spurred scholarly interest in the consequences of environmental administrative punishments, and the relevant literature mainly encompasses two areas. The first focuses on the effects of environmental administrative punishments on enterprises, while the second examines the relationship between environmental regulation and employment.

Existing studies have identified a range of effects of environmental administrative punishments on enterprises. First, in terms of environmental compliance, environmental administrative punishments significantly enhance the environmental governance efforts of penalized enterprises (Chen et al., 2021 [1]), effectively reducing corporate future environmental violations (Gray and Shimshack, 2011 [2]). Moreover, the penalization generates a pronounced industry spillover effect, prompting other enterprises in the same industry to proactively increase their environmental protection investments (Wang et al., 2020 [3]), thereby creating a deterrent effect. Second, regarding green innovation, research has found that environmental punishments may suppress the green innovation level of penalized enterprises (Wang et al., 2023 [4]), but they significantly boost the green innovation activities of their competitors (Ke et al., 2023 [5]), thus driving overall technological upgrading in the industry. Third, in terms of corporate reputation, environmental administrative punishments convey negative signals to the market, resulting in damage to the social image and goodwill of enterprises (Zou et al., 2015 [6]). This reputational loss may further impact the customer relationships and market position of enterprises. Lastly, in terms of financial performance, environmental punishments not only directly affect the current operating revenue of enterprises (Liu et al., 2022 [7]), but also increase the risk of corporate debt default. As a result, studies have shown that the financing costs of penalized enterprises significantly increase subsequently (Ding et al., 2022 [8]).

However, while existing studies have extensively examined corporate environmental, financial, and reputational outcomes, they have paid relatively limited attention to the cross-dimensional effects of such punishments on stakeholders in the social dimension, particularly corporate employees.

Currently, research on the impact of environmental regulation on social employment primarily focuses on its effects on the macro labor market, with existing perspectives exhibiting mutually exclusive characteristics. The “Pollution Haven Hypothesis” suggests that stringent regulations may induce carbon-intensive firms to relocate, thereby leading to local

labor displacement. Conversely, the “Green Jobs” perspective posits that environmental transitions can catalyze new employment opportunities through structural upgrading.

We found that existing studies predominantly examine the impact of environmental regulation on labor markets from a macro perspective, while few adopt a micro-level lens to investigate how environmental administrative punishments—as immediate and punitive micro-shocks—affect firms’ specific hiring decisions and human capital structure.

Furthermore, in early studies on environmental regulation, the literature predominantly employed variables such as pollution discharge fees and voluntary environmental regulation as proxy indicators (Xu et al., 2024 [9]; Bu et al., 2020 [10]). These variables correspond primarily to market-based incentive mechanisms or voluntary regulatory policy. Under such regulatory modes, firms retain a certain degree of discretion in their environmental practices and face gradual, predictable cost pressures associated with environmental compliance.

In contrast, environmental administrative punishments differ fundamentally from these regulatory types in terms of their inherent attributes: they represent a prototypical form of mandatory regulation. Their core logic rests upon the principles of violation punishment and deterrence signaling. Such punishments are characterized by unpredictability and a sudden, substantial escalation of financial burdens. Given these essential distinctions, the analytical frameworks and research findings derived from early environmental regulation studies cannot be directly extrapolated to the context of environmental administrative punishments. Consequently, it is both theoretically and practically imperative to conduct an independent examination of the economic consequences that environmental administrative punishments impose on firms.

Against this backdrop, this study systematically examines the impact of environmental administrative punishments on corporate employee hiring behavior, using Shanghai- and Shenzhen-listed A-share non-financial companies spanning from 2007 to 2022 as a sample. By thoroughly analyzing changes in both the number and structure of employees in penalized enterprises, we seek to uncover the underlying mechanism through which environmental administrative punishments shape corporate employment decisions. Moreover, to refine our analysis and substantiate the theoretical logic, we further investigate the heterogeneous effects of environmental administrative punishments on employment growth across different firm characteristics and external environmental contexts.

This study makes three primary contributions. First, at the theoretical level, we uncover the mechanism through which environmental punishments influence firm employment by operating through dual financial constraints (internal and external perspectives) and advance a “double-edged sword” framework to capture the two distinct facets of its effects: while facilitating the upgrading of human capital structure, it may nevertheless lead to a deceleration in corporate employment growth. Second, methodologically, we construct refined measures of internal and external financial constraints and distinguish among different employee categories to provide a granular analysis of heterogeneous employment responses within firms. This approach allows us to move beyond aggregate employment effects and identify different consequences across worker types. Third, from a policy perspective, our findings provide instructive policy recommendations for the design of environmental regulations, supporting a severity-based regulatory enforcement framework and complementary vocational training systems that mitigate social costs without compromising regulatory effectiveness.

2. Hypothesis Development

Financial constraints are pivotal factors that restrict firms from expanding their workforce (Zhang and Zhang, 2016; Benmelech et al., 2021; Ersahin and Irani, 2020 [11–13]). Prior

research has demonstrated that government policies such as procurement initiatives and job stabilization subsidies can mitigate these financial constraints, thereby promoting an increase in the scale of corporate labor employment (Yu et al., 2026; Liu et al., 2024 [14,15]). Hence, when considering the impact of punitive government actions, some critical questions arise: How will the imposition of environmental administrative punishments by the government affect labor employment in firms? And, do financial constraints play an intermediary role in this relationship?

From the perspective of external financing, when firms effectively fulfill their environmental responsibilities, this can significantly enhance their external reputation and positively influence investor attitudes. Conversely, irresponsible environmental behavior by firms can tarnish their external reputation (Zou et al., 2015 [6]) and trigger punitive actions from stakeholders. Drawing on signaling theory and stakeholder theory, stakeholders—such as financial institutions, customers, and suppliers—often become more concerned about the default risk of enterprises after receiving negative information about firms being subject to environmental administrative punishments. To mitigate their own risks, they may choose to reduce debt financing for the company or increase the cost of corporate debt financing (Ding et al., 2022 [8]). This ultimately manifests as an increase in the external financial constraints faced by the company. Given that financial constraints impede firms from expanding their workforce, this article posits that environmental administrative punishments will lead to a reduction in the scale of corporate labor employment by exacerbating the external financial constraints that firms face. Drawing on the foregoing analysis, this study formulates the following hypothesis.

H1a. *Environmental administrative punishments inhibit employment growth by intensifying external financing constraints.*

However, environmental administrative punishments have a doubly detrimental effect on firms, not only constraining their external financing but also severely impacting their internal financing. According to the financial constraints theory, in imperfect capital markets where information asymmetry and agency problems exist, firms with insufficient internal cash flow tend to face higher costs of external financing. This cost disparity forces them to rely more heavily on internal funds when making investment and employment decisions. In this context, Liu et al. (2022) [7] found that environmental punishments can lead to a decline in business revenue. This reduction in corporate revenue directly translates to a decrease in corporate cash inflows, which exacerbates their internal financial constraints. Moreover, the situation is further complicated by the fact that firms penalized for environmental violations often must bear substantial fines or compensation. This additional financial burden undoubtedly intensifies the severity of their internal financial constraints. Based on this analysis, this article posits that environmental administrative punishments worsen the internal financial constraints faced by firms, leading to a reduction in the scale of labor employment. Drawing on the foregoing analysis, this study formulates the following hypothesis.

H1b. *Environmental administrative punishments inhibit corporate employment growth by intensifying internal financing constraints.*

In conclusion, this article asserts that environmental administrative punishments will have a significant negative impact on corporate employment scales, with financial constraints acting as a crucial intermediary in this process.

H1. *Environmental administrative punishments are negatively associated with corporate employment.*

While environmental punishments may reduce employment on average, their effects are unlikely to be uniform across institutional contexts and firm characteristics.

In terms of the moderating role of ownership type, due to implicit government guarantees, SOEs typically face lower financial constraints and enjoy preferential access to bank credit. For example, Geng and Pan (2024) [16] found that SOEs benefit from a significant “SOE premium” in credit markets, and receive disproportionate credit allocation during stimulus periods (Cong et al., 2019 [17]). In addition, Lin and Tan (1999) [18] pointed out that SOEs often receive direct government subsidies and tax relief when facing regulatory shocks. These institutional privileges alleviate the financial burden of environmental punishments, enabling SOEs to better maintain employment levels. Drawing on the foregoing analysis, this study formulates the following hypothesis.

H2. *State-owned enterprise ownership mitigates the negative relationship between environmental administrative punishments and corporate employment growth.*

Regarding the moderating role of regional labor protection in this relationship: First, as argued by Autor et al. (2007) [19] and Banker et al. (2013) [20], local labor protection policies raise employee dismissal costs, which increase the marginal cost of corporate layoffs. This constraint reduces firms’ incentive to cut employment in response to environmental punishments. Second, in regions with strong labor protection or government emphasis on employment stability, local authorities may intervene to prevent large-scale layoffs following regulatory shocks. This further compels firms to reduce their tendency to downsize employees in response to environmental punishments. Drawing on the foregoing analysis, this study formulates the following hypothesis.

H3. *Local labor protection mitigates the negative relationship between environmental administrative punishments and corporate employment growth.*

In terms of the moderating role of heavily polluting industry characteristics, because various sectors of society pay greater attention to environmental issues in these industries, when firms in heavily polluting industries receive environmental administrative punishments, they are likely to face stronger financial shocks and greater financing frictions than non-heavily polluting firms, thereby amplifying the negative employment effects of such punishments. Drawing on the foregoing analysis, this study formulates the following hypothesis.

H4. *The heavily polluting industry characteristic exacerbates the negative relationship between environmental administrative punishments and corporate employment growth.*

Firms with a higher degree of internationalization tend to develop stronger ties with foreign customers and become more dependent on overseas markets (Zhou et al., 2007; Johanson and Vahlne, 2015 [21,22]). International customers are typically more sensitive to environmental issues and impose stricter sustainability expectations on their suppliers. When a firm is subject to an environmental administrative penalty, these customers may respond by tightening trade credit terms, reducing order volumes, or reassessing ongoing commercial relationships. Such reactions can worsen the firm’s internal and external financing conditions. The resulting increase in financial constraints may, in turn, restrict the firm’s capacity to expand its workforce. Consequently, the negative effect of environmental administrative punishments on employment growth is expected to be more pronounced among firms with greater international exposure.

H5. *Internationalization level exacerbates the negative relationship between environmental administrative punishments and corporate employment growth.*

To provide a clearer depiction of the research logic, we present the theoretical framework in Figure 1.

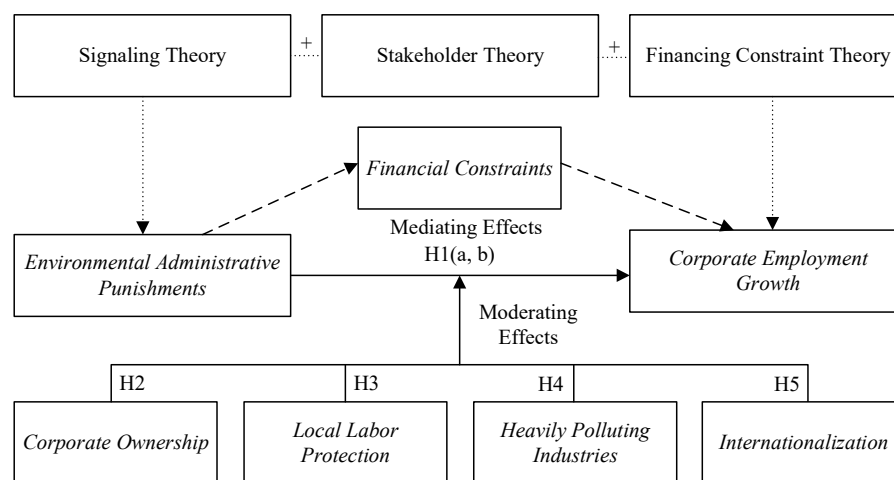


Figure 1. The Theoretical Framework.

3. Research Design

3.1. Sample Selection and Data Sources

Our initial sample consists of Shanghai- and Shenzhen-listed A-share non-financial companies spanning from 2007 to 2022. This study sets 2007 as the starting year because China underwent a fundamental transformation in its accounting and auditing regulatory framework in 2006, with the new standards becoming effective on 1 January 2007.

Our data are sourced from several databases: (1) Firm-level accounting and financial data are obtained from the CSMAR database. (2) Environmental penalty data for firms and their subsidiaries are sourced from the Institute of Public and Environmental Affairs (IPE) website (<https://www.ipe.org.cn/index.html>, accessed on 1 March 2024), where searches are conducted using the full or abbreviated names of the firms and their subsidiaries. (3) Data on employee educational background, research and development background, and skill background are collected from the annual reports of listed companies. (4) The latitude and longitude coordinates of environmental protection bureaus (EPB) are first obtained from the geographic locations provided on their official websites and then determined using the AMAP (Gaode Version 15.0.0) mapping service. (5) Corporate green patent data are acquired from the CNRDS database. (6) Corporate environmental scores are obtained from the Sino-Securities ESG ratings.

To ensure the validity of our sample, we exclude: (1) firms in the financial industry because their employment and financial reporting regulations are different; (2) firms receiving special treatment (labeled as ST or ST*) to avoid the influence of financial abnormality relating to continuous losses over the previous two years; and (3) firm-years with missing values for calculating employment growth and control variables in this study. In total, we obtain 39,561 firm-year observations for 4112 unique firms.

To avoid the impact of extreme values on our conclusions, we winsorize all continuous variables at the 1% and 99% levels. Also, to ensure the robustness of conclusions, this study performs clustering adjustments on standard errors at the firm level during regression analysis.

3.2. Methodology

Our dependent variable is corporate employment growth. We measure it using the change in the natural logarithm of a firm's total employment from t to $t - 1$ to measure employment growth. Our independent variable is an environmental punishment dummy variable. Following Agarwal et al. (2023) [23] and Florackis et al. (2023) [24], this variable is set to 1 if a firm is punished for its environmental violations in a given year, and zero otherwise. Furthermore, referring to Faccio and Hsu (2017), Borisov et al. (2021) and Bao and Yang (2024) [25–27], to exclude the influence of other factors on the regression results, we include the following control variables: state-owned enterprise, corporate size, return on total assets, leverage, cash flow, sales growth, corporate age, board size, independent directors' ratio. The specific variable definitions are detailed in Table 1.

Table 1. Variable definition.

Variable	Definition
Employment growth	The change in the natural logarithm of a firm's total employment at the end of year t relative to that at the end of year $t - 1$.
Punish	A dummy variable that equals one if a firm is punished for its environmental violations in a given year, and zero otherwise.
SOE	A dummy variable that equals one if a firm's ultimate shareholder is a government entity in a given year, and zero otherwise.
Size	The natural logarithm of total assets in a given year.
ROA	The return on total assets in a given year.
Leverage	The total liabilities divided by total assets in a given year.
Cash flow	The operating cash flow divided by total assets in a given year.
Sales growth	The total sales growth rate in a given year.
Firm age	The natural logarithm of the number of years elapsed since a firm was listed.
Bdsize	The natural logarithm of the number of directors in a given year.
Indepr	The proportion of independent directors on the board in a given year.
Year	Year fixed effects.
Firm	Firm fixed effects.

Finally, we use the following model to examine the impact of environmental administrative punishments on corporate employment growth:

$$\begin{aligned}
 \text{Employment growth}_{i,t} = & \beta_0 + \beta_1 \text{Punish}_{i,t-1} + \beta_2 \text{SOE}_{i,t-1} + \beta_3 \text{Size}_{i,t-1} + \beta_4 \text{ROA}_{i,t-1} + \beta_5 \text{Lev}_{i,t-1} \\
 & + \beta_6 \text{Cash flow}_{i,t-1} + \beta_7 \text{Sales growth}_{i,t-1} + \beta_8 \text{Firm age}_{i,t-1} \\
 & + \beta_9 \text{Bdsize}_{i,t-1} + \beta_{10} \text{Indepr}_{i,t-1} + \text{Year}_{i,t} + \text{Firm}_{i,t} + \varepsilon_{i,t}
 \end{aligned} \quad (1)$$

4. Empirical Results

4.1. Descriptive Statistics

Table 2 presents the descriptive statistical results for the main variables in this study. Among them, the mean value of employment growth is 0.053, with a standard deviation of 0.270, which is consistent with findings in prior studies (Bao and Yang, 2024 [27]). The mean value of Punish is 0.042, indicating that about 4% of listed companies have been punished by environmental administration. Table 2 also lists the descriptive statistical results for other control variables, which are similar results found in the existing literature and fall within a reasonable range. This indicates that our data exhibit good reliability.

Table 2. Descriptive statistics.

Variables	Mean	SD	Min	P25	Median	P75	Max	Obs
Employment growth	0.053	0.270	−0.879	−0.047	0.020	0.123	1.357	39,561
Punish	0.042	0.201	0.000	0.000	0.000	0.000	1.000	39,561
SOE	0.396	0.489	0.000	0.000	0.000	1.000	1.000	39,561
Size	21.976	1.323	18.766	21.041	21.810	22.727	26.014	39,561
ROA	0.040	0.072	−0.305	0.014	0.039	0.074	0.251	39,561
Leverage	0.442	0.220	0.052	0.268	0.433	0.599	1.101	39,561
Cash flow	0.046	0.083	−3.222	0.007	0.046	0.088	2.222	39,561
Sales growth	0.187	0.473	−0.637	−0.024	0.113	0.281	3.077	39,561
Firm age	2.219	0.748	0.000	1.609	2.398	2.833	3.367	39,561
Bdsize	8.675	1.745	5.000	7.000	9.000	9.000	15.000	39,561
Indepr	0.372	0.053	0.286	0.333	0.333	0.429	0.571	39,561

4.2. Baseline Results

Table 3 reports the results of the impact of environmental administrative punishments on firms' employment growth. We can see that regardless of whether control variables are included, there is a significant negative correlation between environmental administrative punishments (Punish) and employment growth (Employment growth), which supports Hypothesis 1. This means that firms punished for environmental violations will scale down their employment. The underlying mechanism is that environmental punishments exacerbate firms' financial constraints, thereby leading to a reduction in employment.

Table 3. Baseline results.

Variables	Employment Growth		
	(1)	(2)	(3)
Punish	−0.060 *** (−3.689)	−0.056 *** (−3.018)	−0.058 *** (−3.114)
SOE			0.012 (0.651)
Size			−0.069 *** (−8.304)
ROA			0.064 (1.115)
Leverage			−0.158 *** (−4.575)
Cash flow			0.730 *** (8.247)
Sales growth			0.024 *** (3.106)
Firm age			0.012 * (1.810)
Bdsize			−0.002 (−0.930)
Indepr			−0.047 (−0.690)
Constant	0.056 *** (32.008)	0.044 *** (3.045)	1.548 *** (9.474)
Year FE	NO	YES	YES
Firm FE	NO	YES	YES
Observations	39,561	39,561	39,561
R-squared	0.000	0.081	0.108

Notes: *** and * denote statistical significance at the 1% and 10% levels, respectively.

Furthermore, as shown in Column (3) of Table 3, the estimated coefficient on Punish is -0.058 . Since employment growth is measured via log differences, this estimate translates to an approximate 5.8% reduction in employment growth for penalized firms compared with unpenalized firms. With the sample mean employment growth reaching only 5.3%, this disparity is statistically significant and bears practical economic relevance.

5. Robustness Tests

5.1. Instrumental Variable Method

To ensure the robustness of our findings, we employ the instrumental variable (IV) approach. Our instrumental variable, Distance, is defined as the natural logarithm of the geographic distance (in kilometers) between a firm's headquarters and the local environmental protection bureaus (EPB). The choice of this instrument is motivated by both relevance and exclusion. First, regarding the relevance, geographic proximity lowers the monitoring and inspection costs for regulators. Firms located closer to the EPB impose lower monitoring costs on regulators in terms of on-site inspection time, transportation expenses, and information search costs (Wang and Wang, 2024 [28]). Given limited regulatory resources, the EPB is more inclined to target firms in close geographic proximity for inspections. Against this backdrop, firms nearer to the EPB are associated with a higher probability of environmental violations being detected and penalized. Second, concerning the exclusion, the geographic distance between a firm and the local EPB is largely predetermined by administrative divisions and historical firm location choices. Conditional on firm fixed effects and year fixed effects, there is no clear economic mechanism through which geographic distance would directly influence firm-level employment growth, other than via its effect on regulatory monitoring intensity. Moreover, we control for a comprehensive set of firm characteristics related to employment decisions, including firm size, profitability, financial conditions, growth opportunities, ownership structure, and corporate governance, which helps mitigate the concern that geographic distance may capture differences in firms' economic fundamentals.

As shown in Table 4, the first-stage regression reveals that Distance is significantly negatively correlated with Punish at the 1% level, satisfying the relevance condition for a valid instrument. This suggests that increased geographical distance between a firm's headquarters and the local environmental protection bureau is associated with a reduced probability of the firm incurring environmental administrative punishments. In the second-stage regression, Punish remains significantly negatively correlated with Employment growth at the 10% level, further supporting the robustness of our findings.

Table 4. Instrumental variable method.

Variables	Punish	Employment Growth
	(1)	(2)
Distance	-5.583^{***} (-29.155)	
Punish (Instrumented)		-0.104^* (-1.677)
Controls	YES	YES
Year FE	YES	YES
Firm FE	YES	YES
Observations	39,561	39,561
R-squared	0.190	0.109
First-stage F-value	39.2	

Notes: *** and * denote statistical significance at the 1% and 10% levels, respectively.

5.2. PSM Method

To mitigate the issues of explanatory variable self-selection and model specification bias, this study employs the Propensity Score Matching (PSM) method as a robustness check. First, firm-year observations that received environmental punishments are treated as the treatment group, while those without environmental punishments serve as the control group. Second, we implement 1:3 nearest-neighbor matching without replacement, with exact matching on year and industry. For each treated firm-year observation, three control observations from the same year and industry with the closest propensity scores are matched. The propensity scores are estimated using a Logit model based on all control variables from Model (1), with firm and year fixed effects controlled for. Next, a nearest-neighbor matching method (without replacement) is adopted to match each treated observation with the control observation that has the closest propensity score.

This procedure yields 1259 treated observations and 3777 control observations, consistent with our 1:3 matching design. Table 5 presents the regression results based on the matched sample. As shown in Columns (1) to (3) of Table 5, the estimated coefficients remain significantly negative, indicating that the main findings of this paper remain robust.

Table 5. PSM method.

Variables	Employment Growth		
	(1)	(2)	(3)
Punish	−0.051 *** (−3.733)	−0.044 *** (−2.851)	−0.047 *** (−3.031)
Controls	NO	NO	YES
Year FE	NO	YES	YES
Firm FE	NO	YES	YES
Observations	5036	5036	5036
R-squared	0.001	0.077	0.106

Notes: *** denotes statistical significance at the 1% level.

5.3. DID Method

To address concerns regarding endogeneity, particularly reverse causality and omitted variable bias, we employ a Difference-in-Differences (DID) strategy. Specifically, we exploit the first-time environmental punishment imposed on a firm as an exogenous shock.

We construct the treatment group consisting of firms receiving their first penalty and the control group of firms with no punishments. The DID model examines the change in employment growth surrounding this event. To formally verify the exogeneity of this shock, we follow Bao and Yang (2024) [27] and examine the Cumulative Abnormal Returns (CAR) within the [−5, +30] event window using the market model. As illustrated in Figure 2, the CAR remains relatively flat and statistically insignificant from zero prior to the penalty announcement. This evidence confirms that the first-time penalty is largely unanticipated by the market, thereby satisfying the exogeneity requirement for our DID estimation.

Following the validation of the first-time punishment's exogeneity, we construct our DID model. Specifically, we introduce Post_Punish as the independent variable. This indicator equals one for observations occurring after a firm's first environmental punishment, and zero otherwise. As reported in Columns (1)–(3) of Table 6, the estimated coefficients remain significantly negative, indicating that the main results remain robust.

Furthermore, we conduct an event study analysis to examine dynamic treatment effects. We use the year prior to the first penalty as the base period. As shown in Figure 3, the coefficient estimates are statistically insignificant in the pre-penalty period, indicating

that the treatment and control groups followed parallel trends. The significant effect on employment growth emerges only after the penalty, confirming the dynamic causal impact.

Table 6. DID method.

Variables	Employment Growth		
	(1)	(2)	(3)
Post_Punish	−0.044 *** (−5.506)	−0.038 *** (−3.308)	−0.031 ** (−2.565)
Controls	NO	NO	YES
Year FE	NO	YES	YES
Firm FE	NO	YES	YES
Observations	39,561	39,561	39,561
R-squared	0.001	0.080	0.108

Notes: *** and ** denote statistical significance at the 1% and 5% levels, respectively.

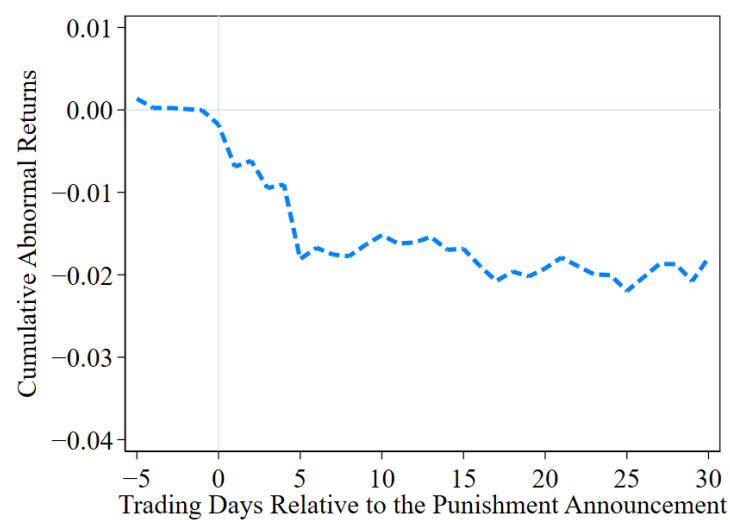


Figure 2. The average CARs for the first-time environmental penalty.

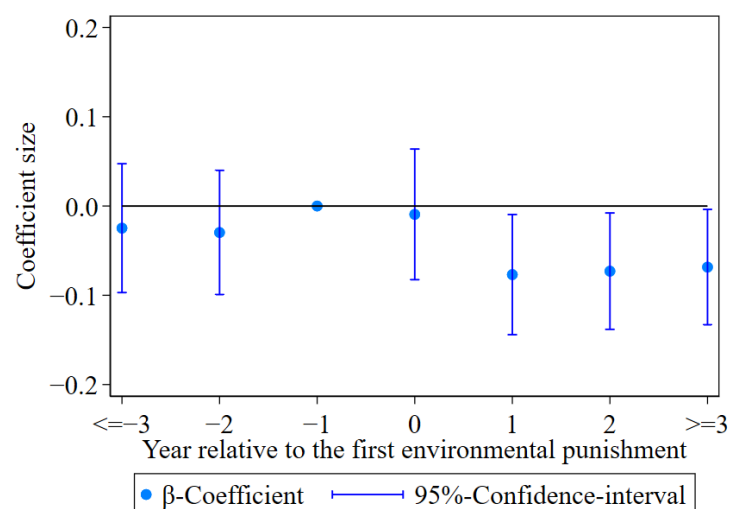


Figure 3. Event Study Figure.

5.4. Different Fixed-Effect Structure

To ensure the robustness of our findings, we further control for industry-year and province-year fixed effects. The specific results are presented in Table 7. As shown, with or

without the inclusion of control variables, there remains a significantly negative correlation between environmental administrative punishments (Punish) and employment growth (Employment growth), which further supports our main conclusion.

Table 7. Different fixed-effect structure.

Variables	Employment Growth	
	(1)	(2)
Punish	−0.055 *** (−2.833)	−0.053 *** (−2.713)
Controls	NO	YES
Year × Industry FE	YES	YES
Year × Province FE	YES	YES
Firm FE	YES	YES
Observations	39,561	39,561
R-squared	0.144	0.168

Notes: *** denotes statistical significance at the 1% level.

5.5. Other Robustness Checks

To further ensure the robustness of our findings, we conducted a series of robustness tests, and the empirical results are presented in Table 8.

Table 8. Other robustness checks.

Variables	Employment Growth					
	(1)	(2)	(3)	(4)	(5)	(6)
Punish	−0.004 ** (−2.108)	−0.009 ** (−2.235)	−0.042 ** (−2.236)	−0.068 *** (−2.819)	−0.051 *** (−2.694)	−0.056 *** (−2.928)
HHI						0.016 (0.416)
Regional punishments						−0.042 (−0.659)
Industry prosperity						0.011 (0.613)
Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	39,561	39,561	39,561	26,019	3,984	39,561
R-squared	0.108	0.108	0.121	0.136	0.138	0.113

Notes: *** and ** denote statistical significance at the 1% and 5% levels, respectively.

Specifically, in Column (1) of Table 8, the main explanatory variable Punish is re-defined as the natural logarithm of the number of environmental punishments imposed on a firm. In Column (2) of Table 8, the main explanatory variable Punish is re-defined as the number of environmental punishments imposed on a firm. In Column (3) of Table 8, the dependent variable Employment growth is redefined as the difference between a firm's employment in year t and year $t - 1$ divided by the firm's employment in year $t - 1$. In Column (4) of Table 8, we remove firm-years from 2008 to 2010 and 2020 to 2022 to exclude the confounding effect of the 2008 financial crisis and the COVID-19 pandemic, respectively. In Column (5) of Table 8, we employ an alternative sample consisting of firms that experience at least one environmental punishment during the sample period. In Column (6) of Table 8, referring to the consideration of provincial and regional factors by Wang et al. (2026) [29] and Xu et al. (2026) [30], we add industry concentration (HHI), the frequency of regional environmental punishments (Regional punishments) and the

degree of industry prosperity (Industry prosperity) as additional control variables to rule out the confounding effects of industry-level market structure and regional environmental enforcement intensity on employment growth. All the above results indicate that the main conclusion of this article remains robust.

6. Mechanism Analysis

According to the previous analysis, financial constraints serve as a crucial mediating channel through which environmental administrative punishments affect corporate employment. To examine this mechanism, this study draws on the methodologies of Wei et al. (2014) [31] and Lee and Wang (2021) [32], employing the KZ index as a positive measure and the Z-score as a negative measure of corporate financial constraints. To further refine the analytical framework, this study references the research of Zhang and Liu (2024) [33] to construct internal financing constraint indicators (In_Finan) and external financing constraint indicators (Ex_Finan). The former is calculated as 1 minus the ratio of cash and cash equivalents to total assets, while the latter is 1 minus the ratio of (current assets minus current liabilities) to total assets. Higher values of these indicators indicate more severe internal and external financial constraints, respectively. Additionally, based on the industry-year medians of each variable, corresponding dummy variables—KZ_high, Z_low, In_Finan_High, and Ex_Finan_High—are constructed. The specific mechanism analysis model is as follows:

$$FC_{i,t} = \beta_0 + \beta_1 \text{Punish}_{i,t-1} + \text{Controls} + \text{Year}_{i,t} + \text{Firm}_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$\begin{aligned} \text{Employment growth}_{i,t} = & \beta_0 + \beta_1 \text{Punish}_{i,t-1} + \beta_2 \text{Punish}_{i,t-1} \times \text{FCdummy}_{i,t-1} \\ & + \beta_3 \text{FCdummy}_{i,t-1} + \text{Controls} + \text{Year}_{i,t} + \text{Firm}_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

In Model (2), FC denotes a series of firm-level financial constraint measures, specifically the KZ index, Z_score, In_Finan, and Ex_Finan. In Model (3), FC_dummy denotes a set of dummy variables capturing distinct financial constraint groups, namely KZ_high, Z_low, In_Finan_High, and Ex_Finan_High. All other variable definitions and control variables in Models (2) and (3) are identical to those in Model (1).

The testing procedure is as follows. First, we estimate Model (2) to assess the association between environmental administrative punishments and corporate financial constraints. Second, we introduce interaction terms between environmental punishments and the financial constraint dummies in Model (3) to investigate the mediating role of financial constraints in the link between environmental administrative punishments and employment growth.

The specific mechanism test results are presented in Table 9. First, Columns (1) and (2) show that Punish is significantly positively correlated with the KZ index and significantly negatively correlated with the Z-score. Meanwhile, Columns (5) and (6) indicate that the interaction terms Punish $\times$ KZ_high and Punish $\times$ Z_low are both significantly negatively correlated with Employment growth. Furthermore, the significance tests for the interaction term have also been passed. These results demonstrate that environmental administrative punishments exacerbate corporate financial constraints, thereby leading to a reduction in corporate employment.

Furthermore, Columns (3) and (4) reveal that Punish exhibits a significantly positive correlation with both In_Finan and Ex_Finan. Meanwhile, Columns (7) and (8) demonstrate that the interaction terms Punish $\times$ In_Finan_High and Punish $\times$ Ex_Finan_High are both significantly negatively associated with Employment growth. Furthermore, the significance tests for the interaction term have also been passed. These results provide more detailed evidence that environmental administrative punishments have a negative impact

on corporate employment by exacerbating both internal and external financial constraints, supporting Hypothesis 1a and 1b.

Table 9. Mechanism analysis.

Variables	KZ Index	Z-Score	In_Finan	Ex-Finan	Employment Growth			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Punish (a)	0.200 *** (2.899)	−0.323 ** (−2.342)	0.008 * (1.932)	0.015 * (1.845)	−0.006 (−0.263)	−0.006 (−0.160)	−0.028 (−0.710)	−0.027 (−0.702)
Punish × KZ_high (b)					−0.081 ** (−2.447)			
Punish × Z_low (c)						−0.059 ** (−2.071)		
Punish × In_Finan_High (d)							−0.015 ** (−2.334)	
Punish × Ex_Finan_High (e)								−0.058 *** (−6.604)
KZ_High					−0.020 *** (−3.172)			
Z_low						−0.084 *** (−11.232)		
In_Finan_High							−0.049 ** (−2.152)	
Ex_Finan_High								−0.049 ** (−2.280)
p-value of (a) + (b)					0.000 ***			
p-value of (a) + (c)						0.007 ***		
p-value of (a) + (d)							0.017 **	
p-value of (a) + (e)								0.022 **
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	39,561	39,561	39,561	39,561	39,561	39,561	39,561	39,561
R-squared	0.690	0.685	0.585	0.769	0.108	0.114	0.108	0.110

Notes: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

7. Cross-Sectional Analysis

The cross-sectional results are reported in Table 10 (To eliminate the potential confounding effects of province-level factors on our research findings, we further incorporate province–year fixed effects into the cross-sectional analysis). In line with our research design, in Column (1), to explore the moderating role of firms' state ownership, we define SOE as a binary indicator of corporate ownership, which takes the value of 1 for state-owned enterprises in a given year and 0 otherwise. Our findings reveal that the negative impact of environmental administrative punishments on corporate employment is relatively weaker in state-owned enterprises, which supports Hypothesis 2.

In Column (2), this study examines the moderating effect of local labor protection on the relationship between the two. We measure regional labor protection intensity using the variable Protection, a dummy indicator that takes the value of 1 if the ratio of labor dispute arbitration cases ruled in favor of employees to total labor dispute cases in a firm's registered province exceeds the annual median across all provinces, and 0 otherwise (a higher proportion of employee wins in labor arbitration implies a greater probability of the firm losing a lawsuit for unlawful dismissal and higher expected compensation costs. Under this logic, this indicator not only directly reflects the increase in the marginal cost of dismissal faced by firms but also indirectly captures the actual enforcement intensity of local labor protection laws. Accordingly, we construct a labor protection dummy variable

based on the ratio of labor dispute arbitration cases ruled in favor of employees to measure the strength of labor protection in the firm's location). We find that stronger local labor protection mitigates the adverse effect of environmental administrative punishments on employment growth, which supports Hypothesis 3.

Table 10. Cross-sectional analysis (the validity of the moderating effect is not determined solely by the significance of the interaction term itself, but by whether the sum of the coefficients on the main effect and the interaction term is significantly different from zero. Specifically, a mitigating effect is supported if this sum is not significantly different from zero in Columns 1 and 2, indicating that the negative impact of penalty exposure is offset. In contrast, an exacerbating effect is supported if this sum is significantly different from zero in Columns 3 and 4, indicating that the negative impact is amplified).

Variables	Employment Growth			
	(1)	(2)	(3)	(4)
Punish (a)	−0.049 ** (−2.105)	−0.097 ** (−2.478)	−0.031 ** (−2.104)	−0.051 *** (−2.796)
Punish × SOE (b)	0.049 * (1.670)			
Punish × Protection (c)		0.073 ** (1.970)		
Punish × Pollute (d)			−0.127 ** (−2.030)	
Punish × Oversea (e)				−0.084 ** (−2.243)
SOE	0.012 (0.571)			
Protection		−0.201 (−1.024)		
Pollute			−0.011 (−0.536)	
Oversea				−0.022 (−1.435)
<i>p</i> -value of (a) + (b)	0.987			
<i>p</i> -value of (a) + (c)		0.218		
<i>p</i> -value of (a) + (d)			0.016 **	
<i>p</i> -value of (a) + (e)				0.002 ***
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Province × Year FE	YES	YES	YES	YES
Observations	39,561	39,561	39,561	39,561
R-squared	0.122	0.122	0.123	0.123

Notes: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

In Column (3), we construct the variable Pollute as a binary indicator for heavily polluting industries, which takes the value of 1 if a firm operates in a designated heavily polluting industry and 0 otherwise. We find the negative relationship between environmental administrative punishments and corporate employment growth is more pronounced in firms located in heavily polluting industries, which supports Hypothesis 4.

In Column (4), this study examines the moderating effect of internationalization level on the relationship between the two. We measure corporate internationalization level using the dummy variable Oversea, which equals 1 if the ratio of a firm's overseas revenue to total revenue is at or above the industry median, and 0 otherwise. We find that the

degree of corporate internationalization strengthens the inhibitory effect of environmental administrative punishments on employment growth, which supports Hypothesis 5.

In summary, the moderating effects of ownership structure and internationalization level can be uniformly traced to the financing constraints mechanism—that is, variations in financing conditions faced by firms with different ownership attributes and degrees of internationalization significantly affect the magnitude of employment shocks induced by environmental administrative punishments. Moreover, the moderating effects of labor protection intensity and industry pollution intensity primarily stem from firms' sensitivity to dismissal costs under social compliance pressure, as well as the degree of public concern over pollution issues.

Regarding the international applicability of our findings in this section, labor protection intensity and industry pollution intensity are institutional and industrial features commonly shared across different countries, rendering our conclusions naturally generalizable across institutional contexts. As for ownership structure and internationalization level, the underlying economic logic ultimately converges on the universal mechanism of financing constraints. The core implication derived from this is that firms should maintain smooth access to financing channels—for instance, by reducing environmental misconduct—so as to effectively mitigate the adverse employment effects of environmental regulations. This implication holds broad applicability across diverse institutional settings.

8. Additional Analysis

To refine our analysis, we categorize corporate employees by type to examine whether the impact of environmental administrative punishments on corporate employment varies across different employee groups, and the empirical results are presented in Table 11.

Table 11. Additional analysis (1)—The employment effect of environmental administrative punishments for employees with different backgrounds.

Variables	Employment Growth					
	Skilled vs. Unskilled Employees		High-Educated vs. Low-Educated Employees		R&D vs. Non-R&D Employees	
	(1)	(2)	(3)	(4)	(5)	(6)
Punish	−0.010 (−0.439)	−0.038 ** (−2.013)	−0.010 (−0.380)	−0.040 ** (−2.029)	0.026 (0.803)	−0.035 *** (−2.580)
Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	29,313	29,313	22,056	22,056	18,256	18,256
R-squared	0.122	0.173	0.174	0.201	0.235	0.280

Notes: *** and ** denote statistical significance at the 1% and 5% levels, respectively.

Specifically, in Columns (1) and (2) of Table 11, we classify employees into skilled and unskilled employees. The regression results indicate that the negative employment effect of environmental administrative punishments primarily occurs among unskilled employees.

Furthermore, as shown in Columns (3) and (4) of Table 11, when employees are categorized by education level, we find that environmental administrative punishments mainly reduce the employment of low-educated employees.

Additionally, in Columns (5) and (6) of Table 11, we divide employees into R&D and non-R&D employees for subsample analysis. The results demonstrate that the adverse employment impact of environmental administrative punishments is concentrated among non-R&D employees.

In summary, our additional analysis results reveal that environmental administrative punishments primarily lead firms to reduce their hiring of lower-quality employees. This raises an important question: Why do firms choose to optimize their human capital structure under the pressure of environmental administrative punishments?

To answer the above question, this study examines the impact of environmental administrative punishments on corporate green innovation under different employee groups.

Specifically, Columns (1) to (4) in Table 12 adopt “the natural logarithm of (one plus the number of green patents that a firm applies for and is ultimately granted) in a given year” as the measure of corporate green innovation intensity. Following Table 11, dummy variables for employee types are constructed: High_skilled takes the value of 1 if the proportion of high-skilled employees in a firm is above the industry median, and 0 otherwise. Similarly, High_educated and R&D are used to determine whether the proportions of highly educated employees and R&D employees in a firm are above the industry median, respectively.

Table 12. Additional analysis (2)—Economic consequences of environmental administrative punishments.

Variables	Green Patents				Envir_Score	
	(1)	(2)	(3)	(4)	(5)	(6)
Punish (a)	0.111 ** (2.056)	−0.092 (−0.831)	−0.140 (−0.928)	−0.074 (−1.042)	−0.132 *** (−2.705)	−0.107 (−1.467)
Punish × High_skilled (b)		0.100 * (1.690)				
Punish × High_educated (c)			0.128 * (1.786)			
Punish × R&D (d)				0.244 ** (2.143)		
High_educated		0.038 (1.565)				
High_skilled			0.045 * (1.826)			
R&D				0.043 * (1.944)		
Punish × Green_high (e)						0.227 ** (2.555)
Green_high						0.036 * (1.814)
<i>p</i> -value of (a) + (b)		0.072 *				
<i>p</i> -value of (a) + (c)			0.093 *			
<i>p</i> -value of (a) + (d)				0.092 *		
<i>p</i> -value of (a) + (e)						0.019 **
Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	39,561	29,313	22,056	18,256	35,010	35,010
R-squared	0.669	0.753	0.705	0.753	0.584	0.561

Notes: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The regression results in Columns (1)–(4) of Table 12 show that the environmental penalty variable (Punish) and its interaction terms with high-quality talent variables (Punish × High_skilled, Punish × High_educated, and Punish × R&D) all have positive effects on the number of green patents (Green patents), though some of the combined-effect significance tests are only marginally passed at the 10% level. These empirical findings provide suggestive, rather than definitive, evidence that firms subject to environmental administrative punishments tend to increase their green innovation investments, while the

presence of high-skilled, highly educated, and R&D employees enables penalized firms better achieve their green innovation objectives.

In Columns (5) and (6) of Table 12, this study employs the Sino-Securities ratings on corporate environmental responsibility to measure firms' environmental performance (Envir_score), while using a dummy variable indicating whether the number of green patents exceeds the industry median (denoted as Green_High) to assess corporate green innovation levels. The regression results in Columns (5) and (6) of Table 12 suggest that firms subject to environmental punishments might significantly improve their environmental responsibility performance by increasing green innovation investments.

In summary, this study proposes that firms subject to environmental administrative punishments tend to optimize their human resource allocation by downsizing low-quality employees. The underlying motivation for this behavior appears to lie in the corporate need to offset the negative impacts caused by environmental violations through enhanced green innovation, thereby improving their performance in environmental responsibility.

9. Conclusions and Discussion

Given the central role of environmental administrative punishments in advancing sustainability, this study examines their employment effects in China and finds that such punishments significantly reduce corporate employment levels. Robustness tests confirm the reliability of these findings. Mechanism analysis reveals that environmental administrative punishments constrain employment growth by exacerbating both internal and external financial constraints. This mediating role of financial constraints is closely tied to the distinctive attributes of administrative punishments. Differing from market-based or voluntary regulations that exert gradual impacts on corporate financing and other operational dimensions, environmental administrative punishments are characterized by unpredictability and a sudden, substantial escalation of financial burdens. Such features ultimately render financial constraints the central channel through which these punishments affect employment outcomes.

Furthermore, the study identifies important moderating effects: state ownership and local labor protection mitigate the negative employment impact of environmental administrative punishments, while heavily polluting industry characteristics and corporate internationalization degree amplify this adverse effect.

It is worth noting that the empirical findings of this study indicate that firms subjected to environmental administrative punishments tend to optimize their human capital structure by reducing the employment of lower-quality workers (e.g., unskilled workers, low-educated workers, and non-R&D workers) to enhance organizational efficiency. The underlying motivation for this behavioral pattern lies in the firms' need to strengthen green innovation efforts to improve their environmental performance, thereby compensating for reputational damage and compliance costs incurred due to environmental violations. Consequently, the actual impact of environmental administrative punishments on corporate human resource management exhibits a notable "double-edged sword" effect: while facilitating the upgrading of human capital structure, it may nevertheless lead to a deceleration in corporate employment growth.

This study reveals an efficiency–fairness dilemma under environmental regulation. Environmental administrative punishments, while reducing the growth rate of corporate employment, force firms to optimize their human capital structure by disproportionately concentrating the negative employment consequences on low-skilled workers. This implies that environmental administrative punishments, while improving corporate employment efficiency, simultaneously exacerbate social employment inequality.

Two structural factors underpin this dilemma. On one hand, low-skilled workers with firm-nonspecific skills and limited negotiating ability absorb most shocks from corporate workforce restructuring, rendering them the primary target of cost-containment strategies. On the other hand, rising regulatory compliance costs incentivize firms to resort to immediate temporary layoffs as a means of alleviating financial strain, rather than financing long-term retraining programs whose economic returns remain ambiguous. This choice persistently locks low-skill labor into a state of employment precarity.

Based on this tension, policymakers require an integrated framework that reconciles environmental regulatory compliance with employment fairness. In line with the strategic principles of “strictly preventing environmental risks” and “promoting high-quality, full employment” set forth in the report of the 20th National Congress of the Communist Party of China, this study proposes the following policy recommendations.

First, at the enterprise level, environmental administrative punishments have been shown to negatively impact corporate employment growth. As key actors in the pursuit of sustainability, enterprises should therefore strengthen their environmental responsibility awareness and proactively reduce regulatory violations, so as to mitigate the adverse effects of environmental punishments on both business operations and society, while contributing to long-term sustainable development.

Second, we recommend a nuanced and conditional penalty mechanism for environmental violations. While severe, intentional, or high-damage violations must still receive strong and immediate sanctions—even for a first offense—to maintain strong deterrence, a more graduated enforcement approach could be applied to minor or technical infractions. For such minor offenses, regulators could combine penalties with compliance assistance and correction periods, such as issuing a warning for the first offense before escalating to fines or production restrictions for repeated non-compliance. This severity-based and multi-layered approach would help alleviate the employment effects of environmental regulations while preserving ecological protection, thus balancing environmental and employment goals.

Third, in terms of labor market policies, which are highly compatible with our empirical findings, particular emphasis should be placed on establishing a comprehensive vocational training system for vulnerable worker groups disproportionately affected by environmental regulations, including low-skilled and less-educated employees. Targeted skill development initiatives, alongside job-placement support and green-skill development, would enhance their human capital quality and improve their employment adaptability. Furthermore, while the government could consider earmarking a fixed proportion of environmental penalty revenue for the retraining of this disadvantaged group, such an approach requires robust governance safeguards and high transparency to prevent fiscal dependency on fines. Alternatively, these retraining funds could be financed through general budgets to ensure structural stability and avoid perverse enforcement incentives.

Finally, it must be emphasized that only through coordinated efforts—with enterprises fulfilling their environmental responsibilities, governments implementing precision policies, and workers upgrading their skills—can we effectively harmonize environmental protection with employment security. This multi-stakeholder approach is essential for achieving comprehensive sustainable development across environmental, social, and governance (ESG) dimensions.

Several limitations should be acknowledged. (1) Measurement limitations. We do not distinguish among environmental penalty types (e.g., fines vs. shutdown orders), as firms often receive multiple concurrent sanctions, making any forced classification arbitrarily biased. Future research could develop severity-weighted indices to capture this multidimensionality. (2) External validity limitations. Our sample is limited to Chinese

A-share listed firms. Since listed firms typically have stronger financing capacity and more formal employment practices than non-listed counterparts, the external validity of our findings for non-listed enterprises is limited. Future research should extend the analysis to non-listed firms. (3) Omitted long-term effects. This study primarily examines short-term employment effects without analyzing long-term dynamic impacts. Penalized firms may gradually mitigate employment suppression through compliance efforts over the medium to long term. Future research could explore this dynamic process using longer time windows. (4) Limited applicability to other institutional environments. Cross-national differences in state-business relations and other institutional factors constrain the generalizability of some of our findings.

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