ISSN: 2710-0170

How Leadership Transition Accountability Mechanisms Drive Environmental Governance Outcomes

Jiaqi Hua, Lin Liu *

Jiangxi University of Finance and Economics, Nanchang, China

* Corresponding Author

Abstract

This study investigates the impact of China's "Audit of Outgoing Officials' Natural Resource Asset Management" policy on urban environmental pollution. Utilizing a multi-period difference-in-differences (DID) model and panel data from 281 cities between 2011 and 2020, we find that the policy significantly reduces pollution. The mechanism analysis reveals that this reduction is primarily achieved through increased environmental penalties, while the effect of environmental aid is not significant. Additionally, heterogeneity analysis shows that the policy's effectiveness varies with local industrial structure and population density, being more pronounced in cities with advanced industrial structures or lower population density. This research provides valuable insights into the role of government auditing in environmental governance and offers recommendations for optimizing policy design and implementation to maximize its environmental benefits and promote sustainable development.

Keywords

Leadership Transition Accountability Mechanism, Environmental Governance, Urban Pollution, Difference-in-Differences (DID) Method.

1. Introduction

Amidst intensifying global environmental crises characterized by resource depletion and ecosystem collapse, nations grapple with reconciling developmental imperatives with planetary boundaries. As the world's largest emerging economy, China faces dual imperatives of sustaining economic growth while addressing systemic ecological degradation—a tension epitomized in its pursuit of institutional solutions under the Ecological Civilization framework. The audit outgoing official's natural resource asset management , is a groundbreaking policy mechanism mandating ex-post accountability for the environmental approach to embedding sustainability within bureaucratic governance.

The Communist Party of China Central Committee and the State Council have explicitly required the implementation of audit outgoing official's natural resource asset management(hereinafter referred to as outgoing audit). The audit system underwent pilot implementation between 2014 and 2017, with nationwide deployment commencing in November 2017[1], establishing this mechanism as a standardized institutional framework. In practice, regions have explored and accumulated rich experience. Zhejiang Province, for instance, pioneered the audit pilot in 2015 and progressively expanded it, creating a regionally distinctive audit model. Huzhou City, one of the first national pilot areas, not only contributed to the development of audit operation guidelines but also incorporated green auditing into its annual assessment of counties for five consecutive years. Lishui City further expanded the audit scope by including the realization mechanism of ecological products. This system audits local officials' management of natural

1 https://www.gov.cn/zhengce/2017-11/28/content_5242955.htm?ddtab=true

ISSN: 2710-0170

resource assets and environmental protection efforts during their tenure, enhancing their environmental awareness and promoting sustainable economic development. It not only boosts environmental governance efficiency but also offers a Chinese approach to global environmental management.

The phased implementation of institutional environmental auditing across Chinese cities since 2014 has created a valuable quasi-natural experiment for policy evaluation research. However, constrained by data availability limitations during the initial policy rollout phase, early scholarship predominantly engaged in normative analyses to deconstruct the institutional logic and operational mechanisms of the outgoing audit system (W. Zhang, 2018). In recent years, some empirical papers have focused more on the impact of this system on corporate environmental performance and its mechanisms (Peng & Li, 2024; Zeng et al., 2022) As the policy has been in place for longer, scholars have started to assess its effects(Cao et al., 2022; Lei, 2020; Zeng et al., 2022). Yet, most existing studies look at only one environmental aspect or factor(Li et al., 2025; Siyiti & Yao, 2024; Yu et al., 2023; Zhang et al., 2024).Few scholars have comprehensively examined the system's governance effects from a macro-environmental perspective or delved into its key mechanisms. Additionally, current research falls short in providing in - depth assessments of the policy's authenticity.

This study investigates the role of government auditing in national governance through an environmental lens, utilizing prefecture-level panel data from 2014 to 2017. Employing a multi-period difference-in-differences (DID) approach, we systematically evaluate the policy effects of audit outgoing officials' natural resource asset management. To elucidate the underlying mechanisms, we establish a dual-path mediation framework incorporating fiscal expenditure on environmental governance and environmental regulation intensity as mediating variables. This methodological design enables us to disentangle the positive incentive effects of fiscal resource allocation from the negative incentive effects of regulatory stringency in environmental governance. Our empirical analysis reveals the operational logic and transmission pathways through which the outgoing audit system influences local governments' environmental governance behaviors, thereby contributing to the theoretical understanding of performance auditing in sustainable governance. The findings provide both methodological and empirical evidence for optimizing the design of vertical environmental management systems under China's cadre responsibility framework.

2. Background and Research Hypothesis

2.1. Institutional Background

China has increasingly prioritized the construction of an ecological civilization to address severe environmental challenges. To combat pollution and promote sustainable development, the government has enacted a series of environmental protection laws, including the *Environmental Protection Law of the People's Republic of China*, the *Law on the Prevention and Control of* Atmospheric *Pollution*, the *Environmental Protection Tax Law*, and the *Measures for Ecological and Environmental Administrative Punishments*. These laws impose strict penalties for violations, underscoring the nation's commitment to environmental governance. To further enhance accountability, the State Council has integrated environmental performance into the evaluation criteria for officials. This system links environmental governance outcomes to officials' career progression, creating strong incentives for prioritizing ecological stewardship.

The concept of auditing officials for their environmental responsibilities was first introduced in the Decision of the Central Committee of the Communist Party of China on Some Major Issues Concerning the Comprehensive Deepening of Reform. Article 52 of this decision, adopted at the Third Plenary Session of the 18th CPC Central Committee in 2013, called for the implementation of natural resource asset departure audits for leading officials. In 2014, the National Audit Office

ISSN: 2710-0170

launched pilot programs in Hubei, Jiangsu, Sichuan, and Shandong provinces. These pilots tailored audit content and priorities to local conditions, providing valuable insights and laying the groundwork for broader implementation. In November 2015, central authorities issued formal guidelines for pilot audits. Following the success of these programs, the audit system was officially rolled out nationwide in November 2017.

2.2. Research Hypothesis

2.2.1. the governance implications of institutional environmental auditing.

Institutional environmental auditing functions as an accountability mechanism that internalizes ecological externalities by directly linking policymakers to resource management outcomes. Empirical studies across nations confirm its substantial environmental governance impacts, achieved through optimized political performance metrics emphasizing eco-environmental indicators, which critically shape officials' regulatory decisions (Sun et al., 2025; W. Zhang, 2018). This dual regulatory instrument simultaneously governs corporate conduct and state oversight, creating a causal chain from government enforcement to corporations' cost-benefit-driven adoption of environmental responsibilities, ultimately translating into measurable ecological improvements(Gao et al., 2024). Under regulatory pressures, enterprises strategically transition toward green development after evaluating long-term costs, fostering autonomous environmental stewardship that enhances ecological outcomes (Cao et al., 2022). China's natural resource asset auditing exemplifies this mechanism, reducing industrial SO_2 emissions by 12.7% while boosting afforestation investment by 9.4%, with cross-national evidence confirming audit-driven compliance through elevated non-compliance costs(Blackman et al., 2010). Therefore, we propose the following research H1：

H1. In the pilot areas where the audit of outgoing leading officials' natural resource accountability is implemented*, the environmental quality will be significantly improved.*

2.2.2. The mediating effect on the relationship between institutional environmental auditing and environmental governance

In existing literature, output data such as government audit reports or penalty announcements is used to conduct post-audit inspection, emphasizing the post-audit accountability function of government audit without paying attention to the behavior of the government itself (Fang et al., 2024;Chen, 2011). Command-and-control tools, also known as coercive policy tools, refer to a series of laws and regulations enacted by the government to urge polluters to implement such laws and regulations and meet environmental standards (Weitzman, 1974).

It is also conducive to the innovation and dissemination of technology. In areas where outgoing audit of natural resources is implemented, local officials can make use of fiscal policy through market forces such as increasing subsidies and tax revenue to encourage the popularization and application of new technologies for energy conservation and emission reduction, support emerging industries, inhibit excessive use of fossil fuels and expansion of heavy polluters, to achieve effective environmental governance. Researchers have suggested that audits can fulfil the mandate of environmental governance by preventing abuses and governance failures in the use and application of environmental funds, and by facilitating the processing of sanctions and preventing their occurrence(Gao et al., 2024, 2024; Wu et al., 2020).Therefore, we propose the following research H2、H3:

H2. In the pilot areas where the audit of outgoing leading officials' natural resource accountability is implemented*, environmental quality will be improved through strengthening environmental supervision.*

H3. In the pilot areas where the audit of outgoing leading officials' natural resource accountability is implemented*, environmental quality will be improved by increasing fiscal expenditure on environmental governance.*

ISSN: 2710-0170

3. Research design

3.1. Sample selection and data sources

The outgoing audit policy was initially piloted between 2014 and 2017. To comprehensively capture policy effects while ensuring temporal comparability, we extend our analysis window to 2011-2020. This extended timeframe accommodates sufficient pre-intervention baseline data and enables robust post-implementation evaluation. Our empirical strategy employs a quasi-experimental design, utilizing 152 pilot cities as the treatment group and 129 non-pilot cities as the control group. The final sample comprises 281 prefecture-level municipalities. The outgoing audit data of natural resource assets are mainly obtained manually from the official websites of governments such as regional audit offices (bureaus). Government expenditure data on environmental governance are obtained by reading the annual report on the work of the government. Data on temperature and precipitation are averaged by collating the raw data from the synoptic network. The remaining data was obtained from regional statistical yearbooks, statistical yearbooks on environment and almanacks of Chinese cities.With the exception of pilot audit data on natural resource asset accountability during leadership tenure transitions, all statistical indicators were obtained from official publications including China Statistical Yearbook, China Environmental Statistics Yearbook, and China City Statistical Yearbook.

3.2. Model Specification

The primary objective of this study is to investigate whether the audit outgoing official's natural resource asset management effectively reduces urban pollution levels. Given staggered implementation timelines across pilot cities (2014–2017), we employ a multi-period difference-in-differences (DID) framework to address heterogeneous treatment adoption. The baseline regression model is specified as follows:

$$Pollution_{it} = \beta_0 + \beta_1 treat_i \times post_{it} + \beta_2 Controls_{it} + City_i + Year_t + \varepsilon_{it} \qquad (1)$$

The dependent variable $Polltion_{it}$ indicates the environmental pollution level of city i in year t. β_0 is the intercept, β_1 reflects the policy treatment effect, and β_2 is the coefficient for control variables. $treat_i$ is a group dummy variable, where 1 indicates city i is in the treatment group and 0 indicates it is in the control group. $post_{it}$ is a time dummy variable, taking the value 1 if the city has been piloted in that year and 0 otherwise. $Controls_{i,t}$ includes the values of various control variables for city i in year t . $City_i$ captures city fixed effects, $Year_t$ captures year fixed effects, and ε_{it} is the random error term.

This study follows the mediation effect test by Wen & Ye, (2014) to examine whether audits reduce urban environmental pollution by increasing environmental aid and penalties. To test the mediation effect of the leaders' natural resource asset audit policy on environmental pollution, we develop mediation models (2)-(5) based on the baseline regression model (1).

The models are as follows:

$$Ev\_penalty_{it} = \beta_0 + \beta_1 did_{it} + \beta_2 Controls_{it} + City_i + Year_t + \varepsilon_{it} \qquad (2)$$

$$Pollution_{it} = \beta_0 + \beta_1 did_{it} + \beta_2 Controls_{it} + \beta_3 Ev\_penalty + City_i + Year_t + \varepsilon_{it} \qquad (3)$$

$$\text{Green Investment}_{it} = \beta_0 + \beta_1 did_{it} + \beta_2 Controls_{it} + City_i + Year_t + \varepsilon_{it} \qquad (4)$$

$$Pollution_{it} = \beta_0 + \beta_1 did_{it} + \beta_2 Controls_{it} + \beta_3 \text{Green Investment}_{it} + City_i + Year_t + \varepsilon_{it} \qquad (5)$$

ISSN: 2710-0170

$Ev\_penalty_{it}$ indicates the environmental penalty intensity of city i in year t.

$Green\ Investment_{it}$ indicates the green investment of city i in year t. Other variables are defined as in Model (1).

3.3. Variables Description

3.3.1. Explained variable

The explained variable in this study is the degree of environmental pollution. The entropy method, an objective evaluation approach, is employed here. It can prevent the bias from subjective weighting and make full use of data, ensuring more scientific and comprehensive results. Therefore, this study uses the entropy method to calculate the environmental pollution levels of each city in the corresponding years, based on three indicators: waste water discharge, SO2 discharge, and smoke and dust discharge.

3.3.2. Explanatoryvariable

The core explanatory variable is did, an interaction term defined as $did = treat \times post$.$treat$ is a group dummy variable: 1 if city i is in the treatment group (i.e., has piloted the natural resource asset audit policy), and 0 otherwise.$post$ is a time dummy variable: 1 if the year is the pilot year or later for city i, and 0 otherwise. Thus, didindicates whether city i had implemented the audit policy by year t (1 if implemented, 0 otherwise).

3.3.3. Control variables

To alleviate the interference caused by omitted variables, the paper referred to previous literature and controlled variables such as economic development level, population density, openness level, fiscal investment intensity, industrial structure, education expenditure level, R&D expenditure level, educational attainment(Zheng et al., 2013; Yu et al., 2014; Sun et al., 2014) . Detailed definitions of all variables are listed in Table 1.

Table 1 Variable definitions

Variable Name	Abbreviation	Definition	Measurement
Explained Variable	Pollution	Environmental Pollution Level	Composite index calculated by entropy method, based on three indicators: wastewater discharge, SO2 emissions, and dust emissions.
Group Dummy	treat	Treatment Group Dummy	Equals 1 if the city belongs to the treatment group, otherwise 0.
Time Dummy	post	Policy Implementation Dummy	Equals 1 if the policy was implemented in the city-year, otherwise 0.
DID Term	did	Interaction Term	treat×posttreat×post; equals 1 for treatment group cities in post-policy years, otherwise 0.
Green Fiscal Support	Green_support	Environmental Fiscal Effort	Fiscal environmental protection expenditure / General fiscal budget expenditure.
Green Investment	Green Investment	Environmental Investment Intensity	Pollution control investment / GDP.
Environmental Penalty	Ev_penalty	Environmental Enforcement Intensity	Total number of environmental penalty cases in the city-year.

ISSN: 2710-0170

Economic Development Level	EC	Log of GDP	ln(GDP).
Population Density	PD	Population Pressure	Resident population / City area (persons/km^2).
Openness Level	DOS	Economic Openness	Foreign direct investment (FDI) / Regional GDP.
Fiscal Investment Intensity	FII	Public Investment Effort	Fixed asset investment / General fiscal expenditure.
Industrial Structure	IS	Industrial Upgrading	Tertiary industry value added / Regional GDP.
Education Expenditure Level	EEL	Public Education Effort	Education expenditure / General fiscal expenditure.
R&D Expenditure Level	LST	Public R&D Effort	Science and technology expenditure / General fiscal expenditure.
Educational Attainment	LE	Human Capital Stock	College and university students / Total population.

3.4. Descriptive Statistics

Table 2 presents the descriptive statistics of the key variables. The environmental pollution level, calculated using the entropy method, is relatively low overall, with a mean value of 0.004. However, the maximum value reaches 0.0901, indicating significantly higher pollution levels in certain cities. Both green fiscal support and green investment exhibit small standard deviations, with minimal differences between their maximum and minimum values, suggesting that cities generally prioritize environmental initiatives. In contrast, environmental penalties show a large standard deviation, reflecting substantial variations in enforcement intensity across cities. The economic development level ranges from a minimum of 2.5934 to a maximum of 8.261, highlighting pronounced disparities in economic conditions among cities.

Table 2 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Pollution	2809	.0004	.0037	0	.0901
Green_support	2809	.0073	.0038	.0004	.0256
Green Investment	2809	.0122	.0047	.0016	.0298
Ev_penalty	1727	196.2085	490.1991	1	6391
EC	2809	5.0786	.9301	2.5934	8.261
PD	2808	5.7531	.9128	.6831	7.8816
DOS	2798	.0169	.0178	0	.1988
FII	2808	4.7354	2.0259	.0124	14.8013
IS	2773	.4185	.1016	.1015	.8387
EEL	2808	.177	.0394	0	.3562
LST	2808	.0168	.0171	.0006	.2068
LE	2798	.0196	.0258	0	.1938

ISSN: 2710-0170

4. Empirical results and analysis

4.1. Baseline regression results

Table 3 reports the baseline regression results. In column (1), the coefficient of the policy variable is significantly negative at the 95% confidence level, indicating that the audit of outgoing leading officials' natural resource accountability exerts a statistically significant suppressing effect on urban environmental pollution without the inclusion of control variables. In columns (2), (3), and (4), control variables are sequentially added to the model. The results demonstrate that the pollution-mitigating effect of the policy remains statistically significant across all specifications, confirming the robustness of the findings.

Table 3 Estimation findings of DID method

Variables	(1) *Pollution*	(2) *Pollution*	(3) *Pollution*	(4) *Pollution*
did	-0.0003** (0.0001)	-0.0004** (0.0001)	-0.0003** (0.0001)	-0.0004** *(0.0002)
$\ln GDP$	—	0.0007*** (0.0003)	—	0.0006*** (0.0002)
PD	—	-0.0001** (0.0001)	—	0.0000 (0.0001)
DOS	—	-0.0062** (0.0025)	—	-0.0095*** (0.0037)
FII	—	—	0.0001** (0.0000)	0.0001** (0.0000)
IS	—	—	-0.0016** (0.0008)	-0.0007 (0.0007)
EEL	—	—	0.0013 (0.0010)	0.0006 (0.0010)
LST	—	—	0.0022 (0.0015)	0.0011 (0.0013)
LE	—	—	-0.0436** (0.0174)	-0.0446** (0.0177)
Year FE	*Yes*	*Yes*	*Yes*	*Yes*
City FE	*Yes*	*Yes*	*Yes*	*Yes*
$\_cons$	0.0004*** (0.0000)	-0.0024** (0.0010)	0.0013** (0.0005)	-0.0017 (0.0010)
N	2809	2798	2763	2753
$R-sq$	0.7854	0.7862	0.7904	0.7912
Adj. R-*sq*	0.7606	0.7613	0.7655	0.7660

Notes: Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

4.2. Event study

Figure 1 shows dynamic effect estimates of the treatment and control groups before and after policy implementation. The x-axis shows time relative to the policy implementation year (t = 0 is the implementation year), and the y-axis shows the estimated treatment effect. Results show that for the five years before policy implementation (t = -5 to t = -1), all time dummy coefficients

ISSN: 2710-0170

are near zero and not significant at the 10% level (p > 0.1), indicating no systematic pre-trend differences between groups and confirming the parallel trends assumption. For the implementation year and subsequent years (t ≥ 0), coefficients are significantly negative, showing the leaders' natural resource asset audit policy sustainably reduces pollution post-implementation. These results confirm the reliability of the baseline findings.

4.3. Robustness test

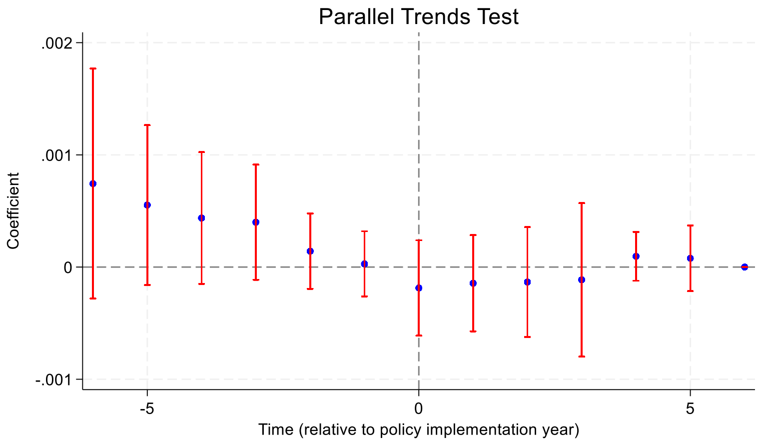

Figure 1 Parallel trend test results

4.3.1. Temporal placebo test

To test the sensitivity of the model to temporal variations and enhance the reliability of the findings, we conducted a temporal placebo test following the approach of Roth et al.,(2023). Based on the baseline regression framework, we artificially shifted the implementation year of the audit of outgoing leading officials'natural resource accountability forward by four and five years for all cities and re-estimated the regression models. As shown in Table 5, the adjusted policy effects remain statistically insignificant (at the 10% level) under both counterfactual scenarios (4-year and 5-year shifts). These results confirm that the original policy effect is robust, indicating that the Audit of outgoing leading officials' natural resource accountability genuinely contributed to reducing urban environmental pollution levels.

Table 4 Temporal placebo test

	(1) *pollution* **(5-year shifts)**	(2) *pollution* **(5-year shifts)**
did	-0.003 (0.002)	-0.002 (0.001)
Control	*Yes*	*Yes*
Year FE	*Yes*	*Yes*
City FE	*Yes*	*Yes*
N	2808	2808

Notes: Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

4.3.2. PSM—DID

To mitigate sample selection bias and ensure pre-policy similarity in characteristics between the treatment and control groups, thereby enhancing estimation accuracy, we conducted

ISSN: 2710-0170

robustness checks using the Propensity Score Matching-Difference-in-Differences (PSM-DID) method.

Specifically, we selected five covariates—economic development level, population density, green investment, scientific and technological level, education expenditure level, and openness level—to match each treatment group unit with its closest counterpart in the control group. After excluding unmatched samples, we re-estimated the model using a multi-period difference-in-differences (DID) framework. The results demonstrate that the pollution-reducing effect of the audit of outgoing leading officials'natural resource accountability remains statistically significant, confirming the robustness of our findings.

Table 5 PSM-DID

	pollution
did	-0.00016* (-1.73)
Control	*Yes*
Year FE	*Yes*
City FE	*Yes*
Number of obs	1419

Notes: Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

4.4. Mechanism Test

As mentioned earlier, this study proposes that the audit of officials' natural resource assets may reduce urban environmental pollution by increasing environmental aid and penalties. This is tested using causal stepwise regression analysis. Models (3) and (4) test whether the leaders' natural resource asset audit policy reduces pollution by increasing environmental penalties. In model (3), β_1 is positive and significant; in model (4), β_1 is negative but insignificant, while β_3 is negative and significant at the 10% level. This suggests that increased environmental penalties fully mediate the reduction in pollution caused by the audit policy, meaning the policy achieves urban pollution reduction by enhancing environmental penalties.

Models (5) and (6) test whether the leaders' natural resource asset audit policy reduces pollution by increasing environmental aid. In model (5), β_1 is positive and significant; in model (6), β_1 is negative and significant, while β_3 is negative but insignificant. This shows the audit policy boosts urban green investment, yet this investment doesn't significantly lower pollution. Thus, the policy fails to reduce urban pollution through enhanced environmental aid. The detailed results are presented in Table 6.

Table 6 Mechanism Test

	(1) *Ev _ penalty*	(2) *Pollution*	(3) Green Investment	(4) *Pollution*
did	107.4119*** (2.81)	-0.002 (-1.16)	0.0047** (2.25)	-0.0036** (-2.5)
$Ev\_penalty_{it}$	—	-2.59e-08* (-1.66)	—	—
Green $Investment_{it}$	—	—	—	-0.00249 (-0.23)

ISSN: 2710-0170

Year FE	*Yes*	*Yes*	*Yes*	*Yes*
City FE	*Yes*	*Yes*	*Yes*	*Yes*
Control	*Yes*	*Yes*	*Yes*	*Yes*
Number of obs	1721	1721	2797	2798
Adj. R-*sq*	0.4791	0.8266	0.5985	0.7611

Notes: Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

4.5. Further Analysis

The pollution-reducing effect of the audit of outgoing leading officials'natural resource accountability may vary across cities due to differences in local characteristics. To investigate this heterogeneity, we conducted subgroup analyses based on industrial structure and population density. Cities were divided into two groups—advanced industrial structure (above-average) and less developed industrial structure (below-average)—based on the mean value of industrial structure. The baseline regression was re-estimated for each subgroup: (1) In cities with advanced industrial structure, the coefficient of the did is significantly negative. (2) In cities with less developed industrial structure, the coefficient of the did term is negative but statistically insignificant .

This indicates that the pollution-reducing effect of the policy varies significantly with industrial structure. Cities with advanced industrial structures (e.g., those dominated by high-tech industries and services) exhibit a pronounced pollution reduction, likely due to their reliance on low-pollution, high-value-added sectors and greater capacity for green innovation. In contrast, cities with less developed industrial structures (e.g., heavy industry or resource-intensive sectors) show weaker effects, possibly due to technological limitations and higher baseline pollution levels.

Cities were categorized into high population density (above-median) and low population density (below-median) groups. Regression results reveal: The coefficients of the did are significantly negative in both subgroups. However, the absolute value of the coefficient is larger in low-density cities compared to high-density cities.

This suggests that the policy's pollution-mitigating effect is stronger in low-density cities. Potential explanations include: Higher policy implementation efficiency in low-density cities, where administrative coordination and enforcement may be more streamlined. Challenges in enforcement in high-density cities, such as complex governance structures and competing priorities, which dilute policy effectiveness.

The heterogeneity analysis underscores that the environmental benefits of the Audit of outgoing leading officials' natural resource accountability depend critically on local industrial structure and population density. Policymakers should prioritize tailored strategies—such as promoting industrial upgrading in resource-dependent cities and enhancing governance capacity in densely populated areas—to maximize the policy's effectiveness.

ISSN: 2710-0170

Table 7 Heterogeneity Analysis

	(1) *Pollution* **(advanced)**	(2) *Pollution* **(less developed)**	(3) *Pollution* **(high-density)**	(4) *Pollution* **(low-density)**
did	-0.0006** (-2.12)	-0.000336 (-0.71)	-0.0000409** (-2.27)	-0.0007986** (-2.52)
Year FE	*Yes*	*Yes*	*Yes*	*Yes*
City FE	*Yes*	*Yes*	*Yes*	*Yes*
Number of obs	1295	1438	1396	1355
Adj. R-sq	0.7633	0.9909	0.5247	0.7721

Notes: Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

5. Conclusions and Policy Implications

5.1. Empirical Findings

This study examines the impact of the leaders' natural resource asset audit policy on urban environmental pollution using a multi-period DID model and panel data from 281 cities between 2011 and 2020. We find that this audit policy significantly reduces urban pollution, and this conclusion holds after conducting parallel trend, placebo, and PSM-DID tests, indicating the policy's effectiveness in pollution reduction. Furthermore, the mediation analysis reveals that the audit policy mainly reduces pollution by increasing environmental penalties, while the pollution reduction effect through environmental aid is not significant. Heterogeneity analysis shows that the policy's pollution reduction effect is stronger in cities with better industrial structures or lower population density.

5.2. Policy Recommendations

Based on these findings, we propose several recommendations. First, the promotion of the natural resource asset audit policy should be intensified, and its coverage should be expanded to more cities and regions. Second, it is essential to establish localized environmental data monitoring and pollution evaluation systems to standardize audit work and ensure the sustainable implementation of the audit policy. Third, the environmental penalty mechanism should be optimized by building digital and intelligent platforms. This will enable precise screening of problematic cases, move away from indiscriminate inspections, and achieve "smart law enforcement." Strengthening environmental penalties can further leverage the audit policy's pollution reduction effect and ensure strict enforcement of environmental regulations. Finally, in cities with less developed industries, efforts should be made to accelerate the transformation of traditional industries towards high-end, intelligent, and green models. This includes reducing the proportion of highly polluting industries, encouraging energy-saving and emission reduction innovations, and gradually phasing out or relocating heavily polluting industries.

The audit of outgoing leading officials' natural resource accountability demonstrates significant potential to curb urban pollution, particularly when aligned with local industrial and demographic contexts. By addressing implementation gaps and leveraging technological advancements, policymakers can amplify its environmental benefits and foster sustainable development.

ISSN: 2710-0170

Acknowledgements

This work was supported by the Undergraduate Training Program for Innovation and Entrepreneurship & Student Research Training Program at Jiangxi University of Finance and Economics.

References

[1] Blackman, A., Lahiri, B., Pizer, W., Rivera Planter, M., & Muñoz Piña, C. (2010). Voluntary environmental regulation in developing countries: Mexico's Clean Industry Program. Journal of Environmental Economics and Management, 60(3), 182–192. https:// doi.org/ 10.1016/ j.jeem.2010.05.006

[2] Cao, H., Zhang, L., Qi, Y., Yang, Z., & Li, X. (2022). Government auditing and environmental governance: Evidence from China's auditing system reform. Environmental Impact Assessment Review, 93, 106705. https://doi.org/10.1016/j.eiar.2021.106705

[3] Chen, C. (2011). Government Audit and National Economic Security. In M. Dai (Ed.), Innovative Computing and Information (Vol. 232, pp. 157–163). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-23998-4_24

[4] Fang, C. J., Ahmi, A., & Sharif, Z. (2024). Government Auditing, Government Transparency, and Corruption: Empirical Evidence from Provincial Levels in China. South Eastern European Journal of Public Health, 1780–1796. https://doi.org/10.70135/seejph.vi.2699

[5] Gao, Z., Zhao, Y., Li, L., & Hao, Y. (2024). The environmental consequences of national Audit governance: An analysis based on county-level data in China. Journal of Environmental Management, 359, 120976. https://doi.org/10.1016/j.jenvman.2024.120976

[6] Lei, J. (2020). Reforming the natural resource auditing system from the ecological civilization perspective. Chinese Journal of Population, Resources and Environment, 18(2), 87–96. https:// doi.org/10.1016/j.cjpre.2019.01.001

[7] Li, S., Shen, J., & Sun, F. (2025). A study on the water resource assets management audit for outgoing officials considering asset elements. Journal of Cleaner Production, 494, 144931. https:// doi.org/10.1016/j.jclepro.2025.144931

[8] Peng, L., & Li, H. (2024). Environmental governance and firm's environmental investment: Evidence from the natural resources and assets accountability audit of outgoing officials. Finance Research Letters, 65, 105545. https://doi.org/10.1016/j.frl.2024.105545

[9] Roth, J., Sant'Anna, P. H. C., Bilinski, A., & Poe, J. (2023). What's trending in difference-in-differences? A synthesis of the recent econometrics literature. Journal of Econometrics, 235(2), 2218–2244. https://doi.org/10.1016/j.jeconom.2023.03.008

[10] Siyiti, M., & Yao, X. (2024). Natural resource assets management and urban carbon emission efficiency: Evidence from quasi-natural experiment in China. Energy Economics, 140, 107963. https://doi.org/10.1016/j.eneco.2024.107963

[11] Sun, L., Luo, K., Zhou, C., & Yan, J. (2025). Can the government environmental audits improve corporate green investment? Evidence from China. International Review of Economics & Finance, 97, 103782. https://doi.org/10.1016/j.iref.2024.103782

[12] Weitzman, M. (1974). Prices Vs. Quantities. Review of Economic Studies, 41, 477–491. https://doi.org/10.2307/2296698

[13] Wen, Z. L., & Ye, B. (2014). Analyses of Mediating Effects: The Development of Methods and Models. Advances in Psychological Science, 22, 731–745. https://doi.org/10.3724/SP.J.1042.2014.00731

[14] Wu, X., Cao, Q., Tan, X., & Li, L. (2020). The effect of audit of outgoing leading officials' natural resource accountability on environmental governance: Evidence from China. Managerial Auditing Journal, 35(9), 1213–1241. https://doi.org/10.1108/MAJ-08-2019-2378

ISSN: 2710-0170

[15] Yu, Y., Bao, Y., Zhang, Q., Shen, P., Yang, H., & Xu, Z. (2023). Evaluation of marine resources environmental responsibility audit based on PSR framework. Ocean & Coastal Management, 245, 106742. https://doi.org/10.1016/j.ocecoaman.2023.106742

[16] Zeng, H., Li, X., Zhou, Q., & Wang, L. (2022). Local government environmental regulatory pressures and corporate environmental strategies: Evidence from natural resource accountability audits in China. Business Strategy and the Environment, 31(7), 3060–3082. https:// doi.org/ 10.1002/bse.3064

[17] Zhang, G., Wang, J., & Liu, Y. (2024). How does auditing outgoing officials' natural resource asset management policies affect carbon emission efficiency? Evidence from a debiased machine learning model. Journal of Cleaner Production, 478, 143932. https://doi.org/ 10.1016/ j.jclepro. 2024. 143932

[18] Zhang, W. (2018). Conducting Natural Resource Assets Departure Audit on Leading Cadres. Journal of Service Science and Management, 11(1), Article 1. https://doi.org/10.4236/jssm.2018.111004