

*Original Research*

# Research on the Impact of Environmental Regulation and Environmental Accountability on Public Satisfaction with Environmental Governance

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## Abstract

Based on the data from the Chinese General Social Survey (CGSS) 2015 and the statistical yearbooks of 89 corresponding prefectures, this paper constructs an ordered probit model and a mediation effect model to explore the logic of how environmental regulation and environmental accountability jointly influence public satisfaction with environmental governance. The results indicate that both the intensity of environmental regulation and the cognition of environmental accountability significantly promote public satisfaction with environmental governance. Notably, public environmental accountability cognition plays a partial mediating role in the influence of environmental regulation on environmental governance satisfaction. Further analysis reveals that this mediating effect is unique to urban groups, with notable differences observed between urban and rural areas. Consequently, this paper suggests policy implications, such as optimizing and innovating the environmental accountability system while actively guiding the public to engage in orderly environmental governance supervision.

**Keywords:** environmental regulation, environmental accountability, public satisfaction with environmental governance

## Introduction

The 1960s and 1970s marked the beginning of international ecological governance. With the publication of *Silent Spring* and *The Limits to Growth*, the international community recognized that human

activities aimed at industrial development and wealth accumulation had caused a serious ecological crisis. Ecological governance has transformed from being merely an environmental field into an international political issue. In today's world, no political party dares to claim that they can ignore environmental changes. Since 2013, the Chinese government has proposed a series of new concepts, ideas, and strategies to promote the construction of ecological civilization in the new

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era. This has provided fundamental guidance and practical paths for ecological environment governance with Chinese characteristics. The promotion of the idea of “ecological civilization” firmly established the concept that “clear waters and green mountains are as valuable as mountains of gold and silver.” This not only shifted the governing philosophy but also significantly boosted the implementation of environmental regulation policies by local governments. The environmental regulation policy system evolved from scratch and underwent transformative developments to reach its full potential [1, 2]. The Chinese government revised the Environmental Protection Law and the Atmospheric Pollution Prevention and Control Law to encourage local governments to take responsibility for environmental governance. They also implemented ecological environment protection inspections and established a system of accountability for ecological protection for party and government leaders. In 2022, the National Conference on Eco-environmental Protection proposed accelerating the construction of a modern environmental governance system, emphasizing the need for accurate and standardized accountability implementation to better supervise and execute environmental protection measures. In the new era, public expectations and demands lie at the heart of ecological environment governance, with public satisfaction serving as a crucial barometer for assessing the performance of such governance [3-5]. Since the emergence of the new public management movement, the academic community has increasingly recognized the theoretical significance of the “satisfaction model” in the context of government performance evaluation [6, 7]. Therefore, research examining public satisfaction with environmental governance holds great theoretical and practical importance.

As China’s environmental governance practices continue to evolve, both research and practitioners have begun to delve into a novel question: whether the harmonious interplay between the enactment of environmental regulatory policies and the oversight of accountability can boost public satisfaction with the government’s environmental governance endeavors. More precisely, does the public hold a favorable view towards the effectiveness of environmental governance under the current regulatory framework? Furthermore, can the intensification of environmental regulations and accountability mechanisms effectively enhance public satisfaction with environmental governance? Existing literature has extensively examined the intersection of environmental regulation, environmental accountability, and public satisfaction, yielding a rich array of findings. Regarding environmental regulation, current research primarily focuses on its impact on objective performance indicators of green development, such as regional economic growth quality [8], ecological efficiency [9], green development performance [10], and the enhancement of social welfare [11, 12]. Environmental regulation is analyzed from two

perspectives: static and dynamic. The static perspective suggests that environmental regulation initially has a restraining effect on green development, while the dynamic perspective argues for its promoting effect over time [13-15]. As research has progressed, scholars have discovered that environmental regulatory policies do not have a simple linear effect but instead exhibit an inverted “U” or “U”-shaped relationship [9, 16].

Regarding environmental accountability, research has paid close attention to the central environmental protection inspection system’s generation logic. Through text analysis, some research has traced the evolution of the environmental accountability system. Recently, much research has focused on environmental accountability performance, exploring its potential to improve environmental governance performance, identifying improvement strategies, and outlining future reform directions. Additionally, research has investigated the relationship between environmental accountability and public satisfaction with environmental governance [17, 18]. It has further revealed that environmental accountability plays a regulatory role in how the government’s environmental protection image impacts public satisfaction with environmental governance. Specifically, it enhances the positive effect of the government’s environmental protection image on satisfaction [3]. The more effective the public perceives environmental accountability to be, the higher their satisfaction with environmental governance. This cognitive relationship is mediated by the effectiveness judgment of environmental complaints [2]. Therefore, research is paying attention to the subjective aspects of environmental accountability and governance. Although there is a belief that there is a close relationship between environmental accountability and governance, there is still a lack of systematic and sufficient theoretical proof of their relationship, and a consistent conclusion on the specific logic has not yet emerged.

In summary, previous research has focused on objective governance performance in terms of environmental regulations and accountability. However, public satisfaction with governance performance may not necessarily align with objective measures [19]. Following the concept of “empowering the public to have a voice”, further research is needed to enrich the study of the perceived environmental governance performance by the public. Moreover, few studies have systematically and thoroughly examined the relationship between environmental regulations, accountability, and public satisfaction with governance, and those that do often lack sufficient theoretical justification. Existing research has not precisely answered the propositions derived from China’s environmental governance practices. Therefore, this study attempts to use the policy implementation cycle theory, combined with the 2015 Chinese General Social Survey (CGSS) and China statistical yearbook data, to construct an ordered probit model and a mediation model to empirically analyze the relationship between environmental

regulations, accountability, and public satisfaction with environmental governance. The ultimate goal is to contribute to the international community's efforts to refine environmental regulations and accountability systems, thus facilitating the identification of solutions to macro-level problems and shaping future strategies for sustainable development.

The main contributions of this paper can be summarized into the following two aspects: Firstly, it examines the subjective performance of environmental regulations and accountability from the perspective of public satisfaction, thus enriching the research perspective of environmental policy performance. The results of this study hold certain significance for the improvement and optimization of environmental regulations and accountability systems, providing useful references for environmental governance. Secondly, within the context of China, this study systematically explores the relationship between environmental regulations, accountability, and subjective environmental governance performance, building upon the policy implementation cycle and satisfaction model. The study offers a more comprehensive overview of China's environmental governance policy characteristics and a more insightful explanation of the "black box" behind China's recent environmental governance achievements.

### Theoretical Analysis and Research Hypothesis

The policy implementation cycle model, proposed by American policy scholars Martin Rein and Frances F. Rabinovitz in 1978, divides the policy execution process into three stages: guideline development, resource allocation, and monitoring. Guideline development and resource allocation fall within the realms of policy formulation and implementation. However, monitoring assesses the process and results to emphasize the administrative responsibility of the implementers. This model introduces monitoring as a crucial component of the policy implementation process, highlighting its significance in preventing issues such as selective implementation and administrative responsibility vacancies. As China's environmental governance practices continue to evolve, a two-stage policy implementation process centered on "supervision" has emerged, encompassing environmental regulation and accountability. Consequently, utilizing the policy implementation cycle model to explore the nexus between environmental regulation and accountability is highly pertinent.

With the deepening of governance reform in China's ecological and environmental sectors, the environmental regulation policy system has undergone a significant strategic transformation. Policy concepts have evolved from "pollution prevention and control" to "ecological civilization." Amidst fervent advocacy for stricter environmental protection laws and the fight

against pollution, the accountability mode, primarily based on environmental protection inspections and talks, has greatly facilitated the implementation of local environmental protection regulations and further refined China's ecological and environmental policy systems [20]. Since the 18th National Congress of the Communist Party of China, this study has explored the relationship between environmental regulation and accountability in the practical context of ecological civilization construction as a key aspect of deepening the reform of the environmental policy system in Chinese ecological and environmental fields. Based on this hypothesis and the policy implementation cycle model, environmental regulation can be viewed as encompassing the stages of guideline development and resource allocation within the narrower scope of environmental policy. Another aspect of vertical environmental accountability centers primarily on environmental protection inspections and discussions as a monitoring stage. Within this framework, it becomes pertinent to assess the performance of environmental policies in the two stages of environmental regulation and accountability. In the delegation-agent relationship between the public and the government and between the central and local governments, public satisfaction with environmental governance emerges as a crucial indicator for measuring the subjective performance of environmental governance services.

This assessment is grounded in the customer satisfaction model, which not only confirms objective performance but also underscores the people-centered governance ethos and the public value inherent in policy services [2, 5]. Therefore, it is feasible to construct a theoretical model (illustrated in Fig. 1) that outlines the relationships between environmental regulation, accountability, and public satisfaction with environmental governance services within the frameworks of the policy implementation cycle and satisfaction models. This model offers the potential to provide empirical evidence and analytical rigor, enabling a deeper understanding of the dynamics at play in environmental policy implementation and its impact on public satisfaction.

### Environmental Regulation and Environmental Governance Satisfaction

Under China's environmental governance model, local governments bear the primary responsibility for environmental management. The effectiveness of environmental protection is closely tied to the performance evaluation and career advancement of local officials. Therefore, local governments have shown high enthusiasm for environmental governance and have successively implemented specific environmental regulation measures, including emission standards, mandatory closures of polluting enterprises, and pollution control measures for livestock and poultry farming. These measures have somewhat improved the

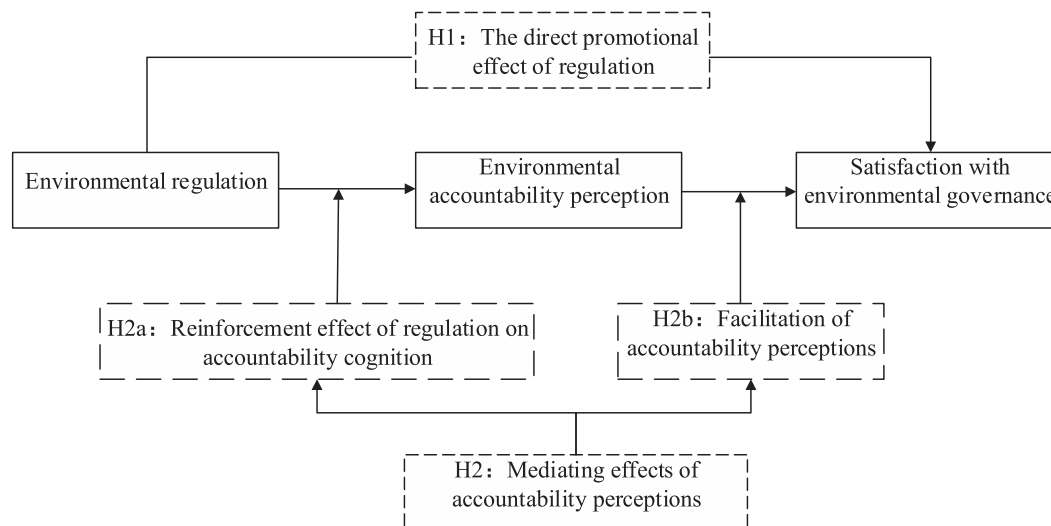


Fig. 1. The theoretical framework model and research hypothesis of this study.

public's living environment and fulfilled expectations for environmental protection. As citizens' awareness of environmental rights gradually rises, the effective implementation of these measures will enhance public satisfaction with environmental governance. However, due to the unprecedented attention paid by the central government to environmental protection, if local governments' regulatory measures fall short of expectations, it is likely to give the public the impression that the government is not taking sufficient action on environmental issues, thereby reducing public satisfaction with environmental governance. In view of this, the following basic hypothesis is proposed:

H1: Environmental regulation has a reinforcing effect on public environmental governance satisfaction. The greater the intensity of local government environmental regulation, the higher the public satisfaction with environmental governance.

#### Environmental Regulation, Environmental Accountability, and Environmental Governance Satisfaction

Based on the policy implementation cycle model, environmental regulation and accountability constitute the two key stages of environmental governance policy execution. During the environmental regulation stage, local governments, confronted with the dual challenge of economic growth and ecological conservation, are susceptible to shifting from being "agent-oriented political operators" towards behaving as "profit-driven political operators," leading to opportunistic decision-making [21]. Environmental accountability, on the other hand, refers to the "government inspection" efforts undertaken by the central government towards local governments via a pressure-driven mechanism. Numerous studies have demonstrated that environmental accountability can significantly enhance the efficacy of environmental regulation [22, 23]. Thus, the greater the

intensity of environmental regulation, the more likely the public is to perceive local governments as proactive political operators and the more faith they have in the effectiveness of central government supervision. Conversely, a decrease in the intensity of environmental regulation may lead the public to believe that central government accountability is weakened.

In view of this, the following basic hypothesis is proposed:

H2a: Environmental regulation has a positive effect on the public's recognition of accountability. The greater the intensity of local government environmental regulation, the more the public believes that the central government's environmental accountability is effective.

In summary, the logic behind environmental accountability perception aims to enhance local governments' awareness of environmental governance within a pressure-based system. It addresses potential issues of agency deviation and selective execution in the delegation relationship between central and local governments through the application of pressure and constraints. Ultimately, this approach aims to improve the efficiency of environmental governance [22]. Based on this logic, examining how accountability cognition affects public satisfaction amounts to analyzing the public's assessment of the government's image or credibility within the context of environmental governance. If local governments fail to rectify misconduct in environmental governance, it will become challenging for them to gain public trust and support. Conversely, if the public believes that local officials who neglect duties in environmental governance will be held accountable, they are more likely to acknowledge their environmental governance efforts, leading to higher satisfaction levels. In light of these considerations, the following hypothesis is proposed to explore the relationship between environmental accountability perception and environmental governance satisfaction:

H2b: Environmental accountability perception has a positive effect on public environmental governance satisfaction.

Combining H2a and H2b, accountability cognition plays an intermediary role in the process of strengthening public satisfaction with environmental regulation. On the one hand, the intensity of the local government's environmental regulation directly affects the public's perception and judgment of the central government's accountability. On the other hand, the public's perception and judgment of the central government's accountability is actually a psychological shaping of the image of the government's active participation in environmental governance, which helps to improve public satisfaction with environmental governance. Therefore, the comprehensive hypothesis on the relationship between environmental regulation, accountability perception, and environmental governance satisfaction is proposed as follows:

H2: Environmental accountability perception plays an intermediary role in the impact of environmental regulation on public satisfaction. The stronger the environmental regulation, the more powerful the public believes environmental accountability perception will be, and the higher public satisfaction with environmental governance will be.

Under China's urban-rural dual system, it must be explored in depth from the perspective of the urban-rural divide. Firstly, there are significant differences in the basic conditions and governance capacity of urban and rural environmental governance. Furthermore, with the tightening of environmental policies, pollution transfer between urban and rural areas has exacerbated existing disparities in environmental governance. Secondly, various research has demonstrated that urban and rural residents hold distinct attitudes and engage in varying behaviors towards environmental governance. For instance, compared to rural residents, urban residents often exhibit a stronger sense of environmental responsibility and demonstrate more proactive environmental protection behaviors [12, 24]. It is primarily driven by their environmental responsibility and behavioral efficacy [25]. Additionally, there is a significant difference between urban and rural residents' understanding of and emphasis on public services due to differences in education levels and employment status. Urban residents often possess more channels for information acquisition and political participation, which directly influence their perception and judgment towards environmental governance work. Given these considerations, it is plausible that there exists urban-rural heterogeneity in the relationship between environmental regulation, accountability perception, and public satisfaction. Based on these observations, the following hypothesis is proposed:

H2c: There are urban-rural differences in the impact of the strength of environmental regulation and the judgment of whether public environmental accountability perception is effective on environmental governance satisfaction.

## Experimental

### Data Source

The Chinese General Social Survey (CGSS), initiated in 2003, stands as the earliest nationwide, comprehensive, and continuous academic survey project in China. CGSS systematically and comprehensively collects data across multiple levels, encompassing society, community, family, and individual, summarizes trends in social change, explores issues of significant scientific and practical importance, promotes openness and sharing in domestic scientific research, provides data for international comparative studies, and serves as a multidisciplinary platform for economic and social data collection. Presently, CGSS data has emerged as the most crucial data source for studying Chinese society and is widely utilized in scientific research, teaching, and government decision-making. The utilization of CGSS2015 data in this study is primarily based on two considerations: (1) CGSS2015 data includes key indicators such as public awareness of environmental accountability and satisfaction evaluation. Additionally, it incorporates information on personal characteristics, human capital, family characteristics, working conditions, and other aspects, thus facilitating a deeper understanding of the public's evaluation and differences in environmental governance, which aligns with the research focus of this paper. (2) The sampling of CGSS data employs a stratified design, and the survey encompasses 31 provinces, municipalities, and autonomous regions in mainland China. With a large sample size and widespread distribution across regions, it is frequently utilized in prior studies on environmental governance and is both authoritative and representative.

The data for the core variable – environmental regulation came from the China Urban Statistical Yearbook, while the other variables were from the CGSS (2015). During the specific analytical process, this study carefully selected environmental governance satisfaction, environmental accountability, and several control variables from the CGSS (2015) dataset. These variables were then merged with the environmental regulation data of various cities to obtain all the necessary data for this study. Invalid data such as “unknown”, “unable to answer”, “refused to answer”, “not applicable”, etc. were treated as missing values and eliminated. Finally, 89 prefecture-level city samples and 3,471 valid samples of public individuals were retained. From the age distribution of the public sample, respondents above 45 years old accounted for 42.07%, approximately one-third of the entire sample, while those aged 45 and below accounted for 57.93%. From the education level distribution of the public sample, 27.78% of the public possess a primary school education level or below, 34.80% possess a junior high school education level, 21.49% possess a senior high school education level, and 15.93% possess a college education level or above. From the source distribution of the public sample,

the urban sample constituted 60.50% of the total sample, while the rural sample made up 39.50%. Overall, the distribution of public individual samples is relatively representative and consistent with the actual population distribution in China, as verified by comparisons with official census data and population statistics.

### Variable Selection Explanation

Environmental regulation is the core explanatory variable. Following the approach of Cole and Elliott (2003) [26], this study uses the ratio of industrial value added to pollutant emissions to measure the intensity of government environmental regulation [27]. The main reason is that pollutant emissions are intuitive data that measure the amount of pollution emitted by enterprises during production activities. The government has made new provisions for energy conservation and emissions reduction and has included a series of pollution indicators in the overall evaluation system for regional economic and social development, indicating that it will pay more attention to pollutant emissions. The higher the regulatory strength, the smaller the pollutant emissions per unit of industrial value added, and the greater the industrial output value brought by the unit of pollutant emissions. Considering data availability and measurement accuracy, the comprehensive ratio of industrial value added to industrial wastewater emissions, industrial exhaust emissions, and industrial solid waste emissions is selected to measure the strength of government environmental regulation. This study uses linear standardization and the averaging of the three pollution emission data points to calculate the regulatory strength of each city. The selected pollution emission indicators are industrial wastewater emissions, industrial sulfur dioxide emissions, and industrial dust emissions in 2015. The calculation method is shown in formulas (1) and (2), where the first step is to linearly standardize each indicator to solve the problem of dimensionlessness.

$$IP_{mn}^s = \frac{IP_{mn} - \min(IP_{mn})}{\max(IP_{mn}) - \min(IP_{mn})} \quad (1)$$

$$IAV_m^s = \frac{IAV_m - \min(IAV_m)}{\max(IAV_m) - \min(IAV_m)} \quad (2)$$

where  $IP_{mn}$  represents the original value of the n-type pollution index in the m city,  $\max(IP_{mn})$ ,  $\min(IP_{mn})$  represent the maximum and minimum values of the pollutant n in the m city, respectively, and  $IP_{mn}^s$  represents the standardization of the pollutant of this type in each city;  $IAV_m$  represents the original value of the industrial value-added in the m city,  $\max(IAV_m)$ ,  $\min(IAV_m)$  represent the maximum and minimum values of the industrial value-added in the m city, respectively, and  $IAV_m^s$  represents the standardization of the industrial value-added in each city ( $m = 1, 2, 3, \dots, 85$ ;  $n = 1, 2, 3$ ).

Secondly, the ratio of industrial value-added to industrial wastewater discharge, industrial exhaust emission, and industrial dust emission is calculated, respectively. In fact, different pollutants cannot be added up due to their different forms of existence. This study uses the method of ratio calculation to measure the industrial output brought by unit wastewater, exhaust gas, and dust emissions. Finally, the average is calculated by summing and averaging the data to assess the strength of environmental regulation, as shown in formulas (3) and (4).

$$ERI_{mn} = \frac{IAV_{mn}^s}{IP_{mn}^s} \quad (3)$$

$$ERI_m = \frac{1}{n} \sum_{n=1}^3 ERI_{mn} \quad (4)$$

where  $ERI_{mn}$  represents the regulatory level of the n-type indicators in the m city, and  $ERI_m$  represents the final environmental regulatory level of the m city.

The environmental accountability variable serves as the mediating variable in this study, assessed through the public's comprehension of environmental accountability in the CGSS (2015) dataset. The pertinent question is: Will government leaders be held accountable for environmental degradation if they blindly prioritize output and neglect corporate emission supervision? The accountability level is denoted by a five-point scale ranging from 1 to 5, indicating very little, sometimes, basically, usually, and always, respectively. A higher score signifies a more stringent accountability level.

The environmental governance satisfaction variable is the dependent variable in this study, measured by the public's evaluation of environmental governance satisfaction in the CGSS (2015) dataset. Specifically, the question asks: "How satisfied are you with the government's performance in the following areas of environmental protection work?" The satisfaction level is categorized into five levels, from 1 to 5, indicating very dissatisfied, dissatisfied, neutral, satisfied, and very satisfied, respectively. A higher score indicates a higher level of public satisfaction with environmental governance.

To increase the credibility and accuracy of the study, we referred to the practices of Shi et al. (2020) [2] and selected the following control variables, which are divided into individual characteristics and regional levels. Individual characteristics include gender, age, education level, political affiliation, health status, personal income, and household registration status; regional control variables include per capita GDP and regional variables. For specific variable definitions and statistical descriptions, see Table 1.

After screening the CGSS data, a total of 3,471 questionnaires were obtained. As for the accountability perception, 48.08% of the respondents believed that

Table 1. Variable selection and data processing.

Variable	Variable name	Variable definition	Processing and assignment	mean	Standard deviation
Core explanatory variable	Environmental regulation	Industrial added value, industrial waste water emissions, industrial waste gas emissions, and industrial solid waste emissions	Values are normalized, summed, and averaged.	0.60	4.74
Intermediate variable	Environmental accountability perception	Will government leaders be held accountable for their one-sided pursuit of output value and negligent supervision of enterprise emissions, resulting in environmental degradation?	Take the original value 1-5. The higher the value, the stronger the accountability	3.27	0.93
Explained variable	Environmental governance satisfaction	Are you satisfied with the government's performance in environmental governance?	Take the original value 1-5. The larger the value, the higher the satisfaction	2.63	1.10
Controlled variables	Gender	What is your gender?	Take the original value: male = 0; female = 1	0.52	0.50
	Age	What is your date of birth?	2015 minus date of birth to get age	49.48	17.19
	Education level	What is your highest level of education?	1 = Elementary school and below; 2 = Junior high school; 3 = High school or junior college; 4 = University and above	2.19	2.81
	Political affiliation	What is your political affiliation?	Mass = 0; party members, league members, democratic parties = 1	0.16	0.37
	Health status	What do you think is your state of health?	Take the value 1-5. The higher the value, the healthier the body	3.65	1.05
	Personal income	What was your total personal income for last year?	Take the original value	28144.52	60239.09
	Household registration nature	What is your household registration status?	Agricultural household = 0, non-agricultural household = 1	0.43	0.50
	GDP per capita	GDP per capita data by region	Take the original value	59352.8	33473.37
	Regional variables	City code	Take the original value	42.70	27.23

Note: Due to space limitations, a list of specific municipalities and their combined environmental regulation values is not included in this study. You can ask the author for a copy if you need it.

when the environment deteriorates, the government is “rarely” or “sometimes” held accountable: 27.66% of the respondents believed that when the environment deteriorates, the government is “basically” held accountable; and 24.26% of the respondents believed that when the environment deteriorates, the government is “usually” or “always” held accountable. Regarding environmental governance satisfaction, 20.63% of the respondents had a “dissatisfied” or “very dissatisfied” attitude, 33.10% had a “neutral” attitude, and 46.27% had a “satisfied” or “very satisfied” attitude. Using data from *the statistics yearbook*, 89 cities in 22 provinces across the country (excluding Hainan, Xinjiang, Tibet, Hong Kong, Macau, and Taiwan) were selected based on the prefecture-level cities involved in the public sample in CGSS (2015) for environmental regulation indicators. After calculating the average value of environmental

regulation in 89 cities, it was found that the average value is 0.84. Nearly half of the cities have above-average levels of environmental regulation, and 80% of the cities have a positive value for environmental regulation, indicating that environmental regulation has a positive effect.

### Model Construction

Public satisfaction with environmental governance was quantified using a five-point Likert Scale method to obtain ordered categorical variables. Its relationship with the intensity of environmental regulation and the perception of environmental accountability was analyzed through ordered probit regression. Using this approach, it established the baseline regression model (represented by Equations (5) and (6) to investigate

how these factors influence public satisfaction with environmental governance.

$$\text{Satisfaction} = a_0 + a_1\text{Regulation} + a_2X_{ij} + a_3Z_j + \lambda_i \quad (5)$$

where  $X_i$  represents a set of individual characteristic control variables.  $Z_j$  illustrates the control variables that account for regional characteristics.  $\alpha_0$  is a constant term.  $\alpha_1, \alpha_2, \alpha_3$  are regression coefficients.  $\lambda_i$  is a random error term.

At the same time, in order to investigate whether the public's strong cognitive perception of environmental accountability as a mediating variable can strengthen the impact of environmental regulation on environmental governance satisfaction, the study used the mediation effect model to investigate the influence mechanism, and the Sobel test was used to test the mediation effect. The Sobel test has higher testing power than the sequential regression test and can screen out insignificant mediation effects. If the P-value of the Sobel test is less than 0.05, the mediation effect is established.

$$\text{Accountability} = c_0 + c_1\text{Regulation} + c_2X_{ij} + c_3Z_j + \lambda_i \quad (6)$$

$$\text{Satisfaction} = a'_0 + a'_1\text{Regulation} + a'_2\text{Accountability} + a'_3X_{ij} + a'_4Z_j + \lambda_i \quad (7)$$

where  $c_1$  represents the mediating effect of whether accountability perception is strong.  $a'_1$  represents the effect of environmental regulation on environmental governance satisfaction.  $a'_1$  represents the effect of accountability perception on environmental governance satisfaction. The control variables in the mediation model are the same as those in the baseline model.  $\lambda_i$  is a random error term.

Formula (5) examines the direct impact of environmental regulation on environmental governance satisfaction, i.e., the overall utility. It demonstrates the aggregate effect of the public's perception of the intensity of environmental regulation on environmental governance satisfaction, represented by  $a_1$ . Formula (6) evaluates the impact of environmental regulation on environmental accountability perception. Formula (7) examines the indirect impact of environmental regulation on environmental governance satisfaction, mediated by the inclusion of accountability perception, i.e., the mediating effect.

## Results and Discussion

### Testing the Effect of Environmental Regulation on Public Satisfaction

A baseline regression was conducted to investigate the relationship between environmental regulation and

satisfaction with environmental governance. Model 1 assessed the influence of environmental regulation intensity on satisfaction with environmental governance. Model 2 combines individual control variables based on the previous model. Model 3 encompassed all individual and regional control variables.

Table 2 reveals that environmental regulation has a positive impact on satisfaction at the 1% level of significance. This indicates that public satisfaction with environmental governance has increased as environmental regulation has increased. The intensity of government environmental regulation was measured through industrial wastewater emissions, industrial exhaust gas emissions, industrial solid waste management, and investment in industrial pollution control using results-oriented measures. These measures provide insights into how effective environmental regulatory measures are and how they significantly elevate the public's perception of the local government's positive actions, ultimately leading to higher satisfaction with the government's environmental governance. Thus, hypothesis H1 is validated.

Regarding the control variables, political affiliation, gender, and hukou status are associated with environmental governance satisfaction, with those who have political status, are male, and have an urban registration reporting higher satisfaction levels. Additionally, age has a significant positive correlation with environmental governance satisfaction, whereas educational attainment, annual income, and per capita GDP are significantly negatively correlated. However, public health status and regional controls are not significantly associated with environmental governance satisfaction. These findings indicate that older people have higher satisfaction with environmental governance, possibly because they have a better perception of government efforts in environmental governance and benefit more from improvements in the ecosystem. Additionally, they tend to be more tolerant and understanding when assessing government environmental governance work. Participants with political identity had a deeper understanding of environmental governance and attachment to government and rated environmental governance higher. Men tend to have higher satisfaction with environmental governance than women, which could relate to previous research indicating that women are less interested in government work and policies [27]. People with higher education and income tend to have more stringent expectations of environmental governance, which can lead to lower satisfaction levels. Urban residents tend to evaluate environmental governance less favorably than rural residents. This could be due to the fact that residents in urban areas are exposed to a broader range of environmental issues and media coverage, potentially leading to higher expectations regarding the effectiveness of environmental governance. Furthermore, the complexity of the urban environment, which is subject to various factors contributing to environmental pollution,



Table 2. Results of regression analysis of environmental regulation and accountability on satisfaction with environmental governance.

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Environmental regulation	0.024*** (0.000)	0.024*** (0.000)	0.022*** (0.000)	-	-	-
Environmental accountability	-	-	-	0.088*** (0.000)	0.090*** (0.000)	0.093*** (0.000)
Gender	-	-0.111* (0.003)	-0.104* (0.006)	-	0.062* (0.096)	0.059 (0.112)
Age	-	0.004*** (0.004)	0.004*** (0.002)	-	0.001 (0.518)	0.001 (0.563)
Education level	-	-0.035*** (0.000)	-0.033*** (0.000)	-	0.008 (0.123)	0.007 (0.224)
Political Affiliation	-	0.171*** (0.001)	0.159*** (0.003)	-	0.162*** (0.002)	0.168 (0.000)
Health status	-	0.003 (0.884)	0.001 (0.958)	-	0.008 (0.668)	0.008 (0.667)
Personal income	-	-0.000*** (0.003)	-0.000* (0.011)	-	-0.000 (0.795)	-0.000 (0.579)
Household registration	-	-0.150*** (0.001)	-0.128** (0.004)	-	-0.105** (0.014)	-0.128 (0.004)
GDP per capita	-	-	-0.000* (0.035)	-	-	0.000** (0.008)
Prefecture-level city	-	-	-0.000 (0.264)	-	-	0.001* (0.077)
Sample size	3,471	3,471	3,471	3,471	3,471	3,471

Note: \*, \*\*, \*\*\* denote the significance levels of 10%, 5%, 1%, respectively. Model (5) is the test results of adding individual variables to the baseline model (4). Model (6) is the test results of adding individual and regional variables to the baseline model (4). “-” indicates that the variable was not put into the regression model.

such as industrial and transportation activities, may also contribute to these lower evaluations.

### Examining the Mediating Effect of Environmental Accountability Perception

The mediating effect of environmental accountability perception was assessed in three steps. Firstly, using public satisfaction with environmental governance as the dependent variable, environmental accountability perception and other control variables were included in the model to examine the direct impact of environmental accountability perception on public satisfaction, as demonstrated in Models (4), (5), and (6) in Table 2. Secondly, environmental regulation was used as the independent variable to evaluate its mediating effect on accountability perception, as illustrated in Model (7) in Table 3. Thirdly, environmental regulation, accountability perception, and other control variables were simultaneously included in the model to examine the mediating effect of accountability perception, as presented in Model (8) in Table 3.

Model (6) in Table 2 disclosed a positive association between environmental accountability perception and public satisfaction with environmental governance, with regression coefficients significant at the 1% level

of statistical significance. Thus, the more powerful the public perceives environmental accountability to be, the greater the satisfaction with the government’s governance performance. As citizens’ awareness of rights continues to increase, leading to a growing discrepancy between demands for environmental quality and the government’s governance capacity, this discrepancy has become a significant contradiction in the environmental governance area. Not only does the public enhance awareness of the government’s environmental governance responsibilities, but they also pay more attention to supervising and constraining the government’s power. These perceptive changes have become critical factors influencing the public’s trust and satisfaction with the government. In conclusion, a reasonable explanation of the positive relationship between environmental accountability perception and public satisfaction with environmental governance has been established, thereby validating H2a.

According to Model 7 in Table 3, environmental regulation has a significant positive impact on accountability perception at a 10% significance level. This finding indicates that as the intensity of environmental regulation increases, the public’s perception of government environmental accountability also strengthens. Both environmental regulation and

Table 3. Intermediation effect test and robustness test.

	Oprobit		OLS	
	Model (7)	Model (8)	Model (9)	Model (10)
Variables	Environmental accountability	Environmental governance satisfaction	Environmental accountability	Environmental governance satisfaction
Environmental regulation	0.007* (0.073)	0.072*** (0.000)	0.007* (0.096)	0.019*** (0.000)
Environmental accountability	-	0.021*** (0.000)	-	0.063*** (0.000)
Individual control variables	Controlled	Controlled	Controlled	Controlled
Regional control variables	Controlled	Controlled	Controlled	Controlled
Sample size	3,471	3,471	3,471	3,471

Note: \*, \*\*, \*\*\* indicate the significance levels of 10%, 5%, 1%, respectively. “-” indicates that the variable was not put into the regression model.

environmental accountability play crucial roles in environmental governance. Environmental regulation involves the government's efforts to predict and prevent potential environmental problems. It demands strict enforcement of policies during environmental management to mitigate risks. Meanwhile, environmental accountability focuses on supervising related departments and officials for their irresponsible actions following environmental incidents. From the perspective of environmental governance, both environmental regulation and accountability are actions taken by the government. However, the main difference lies in their active and passive natures. Environmental accountability actively promotes the standardization and effectiveness of environmental regulation by supervising and guiding post-problem behavior. Conversely, environmental regulation passively responds to environmental issues under the pressure of accountability. Thus, when the public observes a stronger intensity of local government environmental regulation, they perceive a more significant role for centralized accountability. This perception is supported by the positive impact of environmental regulation on accountability perception. Thus, H2b is confirmed, highlighting the interconnectedness of environmental regulation and environmental accountability in environmental governance.

The statistical test of hypotheses H2a and H2b confirms hypothesis H2, indicating that the effect of environmental regulation on public satisfaction with environmental governance is partially mediated by environmental accountability perception, leading to a partial mediating effect. In practice, intensified environmental regulation can strengthen the perception of the government's determination and active efforts towards environmental governance, which in turn enhances the public's perception of the government's capacity for environmental accountability. With a stronger sense of government

environmental accountability, the public is more likely to develop positive evaluations of the government's environmental governance performance. Conversely, if the public perceives weaker government environmental accountability, public satisfaction with government environmental governance may be compromised. Therefore, environmental regulation impacts public satisfaction with environmental governance by influencing the public's perception of environmental accountability through regulation, ultimately affecting public satisfaction with government environmental governance.

#### Urban-Rural Heterogeneity Test

The Chinese dualistic urban-rural system creates significant heterogeneity between urban and rural areas due to differences in economic opportunities, resource accessibility, natural environment, geography, and infrastructure. Because of this difference in public service experience, it is necessary to test each area separately and analyze the different mechanisms that affect their satisfaction with the environment.

After regressing the intermediate model shown in Table 4 on the grouped samples, it was found that the mediation effect remained significant in the urban sample even after controlling for individual and regional variables. This implies that in cities, stronger environmental regulation leads to a greater perception of environmental accountability, which in turn leads to higher satisfaction with environmental governance. The study tested the intermediary effect and confirmed its significance in urban areas. However, the environmental accountability coefficient is not significant in the rural sample, suggesting that environmental accountability cannot be used as a mediator. According to the mediation test, if either  $c_1$  or  $a'_2$  is not significant, the last test is directly conducted via the Sobel test. After testing, the Sobel test value was found to be significant

Table 4. Results of regression analysis of urban-rural heterogeneity.

Variables	Urban areas		Rural areas	
	Environmental accountability	Environmental governance satisfaction	Environmental accountability	Environmental governance satisfaction
Environmental regulation	0.005 (0.233)	0.020*** (0.000)	0.029** (0.027)	0.024*** (0.000)
Environmental accountability	-	0.083*** (0.000)	-	0.042 (0.126)
Individual control variables	Controlled	Controlled	Controlled	Controlled
Regional control variables	Controlled	Controlled	Controlled	Controlled
Sample size	2,100	2,100	1,371	1,371

Note: \*, \*\*, \*\*\* indicate the significance levels of 10%, 5%, 1%, respectively. “-” indicates that the variable was not put into the regression model.

at  $P = 0.12 > 0.1$  ( $P < 0.1$  is significant). This demonstrates the inadequacy of environmental accountability. In the rural sample, environmental regulation directly impacts the level of satisfaction with environmental governance, and environmental accountability does not play an intermediary role. With the development of urbanization and industrialization, urban residents have become more environmentally aware [28] and have a greater understanding of the significance of environmental accountability. Additionally, their access to diverse information channels leads to increased scrutiny and oversight. Urban residents tend to express higher satisfaction levels when they perceive efficient and effective environmental governance supervisory processes. In contrast, the satisfaction of rural residents depends more directly on their government’s environmental regulation behavior.

### Robustness Test

In order to improve the reliability and credibility of this study, a robustness test was conducted by using an alternate test method that replaces the measurement of public satisfaction with environmental governance from the ordered-probit model with Likert’s five-level scale. Some researchers believe that the ordinary least squares (OLS) regression method can treat ordinal variables as continuous numerical processing. Research has compared the two regression methods and found that there is no difference between OLS estimation and ordered-probit estimation methods, and the estimation results of the two methods are not significantly different when the model is set correctly. Therefore, this study uses the OLS method to test the regression results again. The results of the robustness test are shown in Table 3. The robustness test results show that the regression results of models (9) and (10) are both robust. Although the coefficients of the main variables differ in size, the signs remain consistent, and they are significant at the 1% significance level, thus further increasing the robustness of the conclusions of the study.

### Discussion

This study attempts to establish a connection between the government’s environmental governance behavior and public evaluation. Using data, it examines the relationship between environmental regulation, accountability, and public satisfaction with environmental governance based on theoretical logic. Public satisfaction with environmental governance serves as an important criterion to assess the effectiveness of government environmental governance efforts. Therefore, collecting and understanding the public’s evaluation of environmental governance is an important basis for improving the effect of government environmental governance. Environmental accountability, as a binding mechanism of the government’s environmental governance behavior, promotes the interaction between the government and the public. First, it is worth noting that public engagement is not just a tool for enhancing trust, but also a catalyst for expanding environmental awareness. This awareness, in turn, fosters a sense of responsibility and agency among the public, driving them to actively participate in and contribute to environmental protection efforts. In addition, the transparency and accountability generated by public scrutiny create an enabling environment for government officials to disseminate critical environmental information. This dissemination not only expands the reach and impact of such information, but also ensures that information is disseminated in a timely and accurate manner. Consequently, this transparency and accountability promote more informed and responsible decision-making among government officials and the public. In addition, soft constraints imposed on government environmental regulation through public participation act as a check and balance mechanism. It ensures that regulations are not only enforced, but also respond to and adapt to changing environmental conditions. This flexibility is critical in regions where environmental governance is particularly strong, as it enables effective

implementation and enforcement of environmental accountability. Together, the results highlight the critical role of public participation in improving the effectiveness and sustainability of environmental governance efforts. Our results highlight the need for governments to actively encourage and promote public participation in environmental issues, as this not only helps build trust and transparency, but also contributes to more informed and responsible decision-making. Ultimately, this promotes a more comprehensive and inclusive approach to environmental governance that benefits present and future generations.

This study has carried out theoretical discussion and empirical testing on environmental regulation, accountability, and public satisfaction with environmental governance, but it is still necessary to explore the complexity and impact of public participation in environmental governance more deeply. For example, why does the mediating effect of environmental accountability on the impact path of environmental regulation and public satisfaction with environmental governance differ between urban and rural areas? Is there a situational effect on public satisfaction with environmental governance? The above issues are unresolved questions in this study and need to be further explored.

### Conclusions

Starting from China's environmental governance practices, this study theoretically analyzes the logic of the impact of environmental regulations, accountability, and public satisfaction with environmental governance based on the policy implementation cycle and satisfaction model. Using CGSS (2015) microdata and China statistical yearbook data from 89 corresponding prefectures, an ordered probit model is constructed to empirically test the enhancing effect of environmental regulations and the perceived intensity of environmental accountability on government environmental governance satisfaction. The establishment and improvement of environmental governance-related systems are important manifestations of a responsible government and a necessary path to shaping a good government image, which can effectively enhance public confidence and satisfaction with government environmental governance. On this basis, a mediation effect model is constructed to further test the mediation effect of public environmental accountability in the path of environmental regulations' impact on environmental governance satisfaction. Environmental regulations positively affect the public's perception of the intensity of environmental accountability, thereby enhancing the public's satisfaction evaluation of government environmental governance. Subsequently, the model's robustness is tested through the substitution test method, further validating the research findings. In addition, the study also shows that there are significant urban-rural

differences in the mediation effect of environmental accountability. The mediation effect is significant in the urban public sample, while in the rural sample, the mediation effect of environmental accountability is not significant. The difference in mediation effects between urban and rural areas needs further exploration.

According to the comprehensive research findings, we suggest advocating for the following policies to promote more effective environmental governance:

(1) Optimize the environmental accountability system. Strengthened environmental accountability is crucial to gaining public support for local governance work and fostering polycentric governance through public participation. This is essential for establishing a robust environmental accountability framework. To prevent reckless behavior, it is necessary to minimize the post-facto accountability system and ensure that officials are held accountable and severely punished. Normalizing accountability systems and providing follow-up support for local governments to effectively implement corrective measures is imperative. Additionally, the central environmental protection department must devise new accountability tools with genuine punitive powers, such as follow-up visits to encourage increased law enforcement actions by local governments and re-accountability mechanisms to extend the chain of pressure transmission.

(2) Actively guide the orderly participation of the public in environmental governance supervision. Public participation in environmental governance can alleviate trust crises stemming from information asymmetry, raise environmental awareness among the public, and enhance their sense of participation and agency. This can enhance their satisfaction with governance work and urge governments at all levels to be more active in environmental protection. When government affairs are made transparent and subject to public scrutiny, the government and its officials are motivated to actively disseminate environmental information, broadening the avenues for its dissemination and creating a soft constraint on environmental regulation. Encouraging public participation in monitoring is crucial for improving local governance structures and facilitating the effective enforcement of the environmental accountability system, particularly in regions where environmental governance is particularly robust.

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### Conflict of Interest

The authors declare no conflict of interest.

### References

- ZHANG X.Y., LIU J.J. Observation of the Changes and Directions of Environmental Regulation Policies in China's 70 Years-CNKI Reform, **35** (10), 16, **2019**.
- SHI D., WANG C.J., YAO X.H. Mechanism Study on the Influence of Environmental Accountability and Complaints on Environmental Governance Satisfaction-CNKI. *China Population, Resources and Environment*, **30** (9), 21, **2020**.
- SU Y.S., TANG F. How Does Internet Use Affect the Public's Satisfaction with Environmental Governance? An Analysis of the Mediating Effect of Government Environmental Image Based on Environmental Accountability Regulation-CNKI. *Social Policy Research*, **6** (3), 44, **2021**.
- TANG X., ZHOU S.J., ZHAO X.R., WANG Y. Responsiveness Spillover and Central-Local Relations: An Empirical Study Based on Chinese Public's Environmental Satisfaction-CNKI. *Management World*, **36** (6), 120, **2020**.
- PANG R., ZHENG D., SHI M.J., ZHANG X.L. Pollute first, control later? Exploring the Threshold of Effective Environmental Regulation in China's Context. *Journal of Environmental Management*, **238**, 109275, **2019**.
- FAN B., JIN J. The Impact Mechanism of Public Service Supply on Perceived Performance of Public Services: The Mediating Role of Government Image and the Moderating Effect of Public Participation-CNKI. *Management World*, **32** (10), 50, **2016**.
- HO T.A., CHO W. Government Communication Effectiveness and Satisfaction with Police Performance: A Large-Scale Survey Study. *Public Administration Review*, **77** (2), 228, **2017**.
- HAN X., CAI Q. Environmental regulation, green credit, and corporate environmental investment. *Innovation and Green Development*, **3** (3), 100135, **2019**.
- CHEN B., OU Y., YE C., CHEN L. The Impact of Environmental Regulation on Logistics Efficiency along the Yangtze River Economic Belt. *Polish Journal of Environmental Studies*, **32** (5), 3971, **2023**.
- LI X.L., ZHU B.H. Influence of Environmental Regulation on Cross-Border Ecommerce Export of Agricultural Products. *Journal of Environmental Protection and Ecology*, **22** (3), 1347, **2021**.
- OUESLATI W. Growth and Welfare Effects of Environmental Tax Reform and Public Spending Policy. *Economic Modelling*, **45**, 10, **2015**.
- KOTANI K., KAKINAKA M. Some Implications of Environmental Regulation on Social Welfare under Learning-by-Doing of Eco-Products. *Environmental Economics and Policy Studies*, **19** (1), 121, **2017**.
- KORHONEN J., PATARI S., TOPPINEN A., TUPPURA A. The Role of Environmental Regulation in the Future Competitiveness of the Pulp and Paper Industry: The Case of the Sulfur Emissions Directive in Northern Europe. *Journal of Cleaner Production*, **108**, 864, **2015**.
- CHAKRABORTY P., CHATTERJEE C. Does Environmental Regulation Indirectly Induce Upstream Innovation? New Evidence from India. *Research Policy*, **46** (5), 939, **2017**.
- YU D.S., LI X.P., YU J.J., LI H. The impact of the spatial agglomeration of foreign direct investment on green total factor productivity of Chinese cities. *Journal of Environmental Management*, **290** (1), 112666, **2021**.
- LIU J., XUE Y. Fiscal Decentralization and High-Quality Economic Development: The "U-shaped" Moderating Effect Based on Environmental Regulation-CNKI. *Journal of Hebei University (Philosophy and Social Science Edition)*, **46** (1), 58, **2021**.
- LI, X.Y., XU H.Z. Effect of local government decision-making competition on carbon emissions: Evidence from China's three urban agglomerations. *Business Strategy and the Environment*, **29** (6), 2418, **2020**.
- DENG F.H., LIU L.M., TIAN Q.L., GAO Y.H., SUN L.J. Research on Ecotourists' Environmental Responsibility and Ecotourism Cognition Based on Place Attachment. *Journal of Environmental Protection and Ecology*, **21** (3), 954, **2020**.
- TAN Y., MAO X. Assessment of the policy effectiveness of Central Inspections of Environmental Protection on improving air quality in China. *Journal of Cleaner Production*, **288** (12), 125100, **2020**.
- PAN D., HONG W. Benefits and costs of campaign-style environmental implementation: evidence from China's central environmental protection inspection system. *Environmental science and pollution research international*, **29** (30), 45230, **2022**.
- WU J., WANG R. Does Environmental Accountability Improve the Efficiency of Local Government Environmental Governance? An Empirical Analysis Based on the Double Difference Method-CNKI. *Journal of Public Management*, **16** (1), 54, **2019**.
- BRUMBY J. Environmental Governance and Greening Fiscal Policy-Government Accountability for Environmental Stewardship. *International Review of Public Administration*, **27** (3), 277, **2022**.
- NIE W. Environmental Cognition, Environmental Responsibility, and Low Carbon Emission Behavior of Urban and Rural Residents-CNKI. *Science and Technology Management Research*, **36** (15), 252, **2016**.
- GU H. Urban-Rural Differences in Chinese Residents' Environmental Behaviors and Influencing Factors: An Analysis Based on 2013 CGSS Data-CNKI. *Hebei Academic Journal*, **41** (2), 198, **2021**.
- YIN X.M., CHEN D.D., JI J.Y. How does environmental regulation influence green technological innovation? Moderating effect of green finance. *Journal of Environmental Management*, **342**, 118112, **2023**.
- COLE M.A., ELLIOTT R.J.R. Do Environmental Regulations Influence Trade Patterns? Testing Old and New Trade Theories. *The World Economy*, **26**, 1163, **2003**.
- ZHANG J.P., CHENG M.W., WEI X.Y., GONG X.M., ZHANG S. Internet Use and Satisfaction with Governmental Environmental Protection: Evidence from China. *Journal of Cleaner Production*, **212**, 1025, **2019**.
- LI W.B., SHEN H., LI Y.T. Objective Performance, Trust, and Public Satisfaction: An Exploration Based on Survey-Experiment Method-CNKI. *Public Administration Review*, **12** (4), 27, **2019**.

