

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

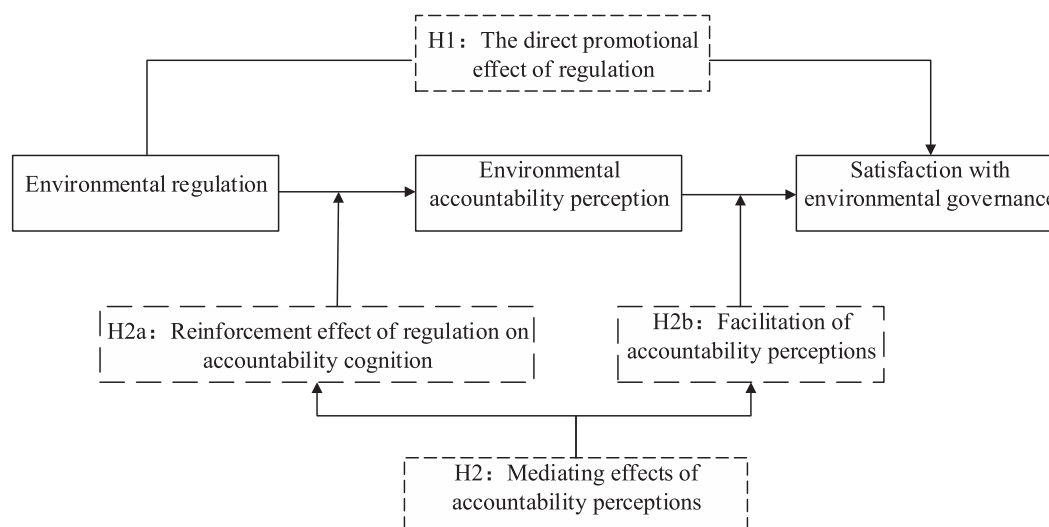


Fig. 1. The theoretical framework model and research hypothesis of this study.

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:

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

how these factors influence public satisfaction with environmental governance.

$$Satisfaction = a_0 + a_1Regulation + a_2X_{ij} + a_3Z_j + \lambda_i \quad (5)$$

where X_i represents a set of individual characteristic control variables. Z_j illustrates the control variables that account for regional characteristics. α_0 is a constant term. $\alpha_1, \alpha_2, \alpha_3$ are regression coefficients. λ_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.

$$Accountability = c_0 + c_1Regulation + c_2X_{ij} + c_3Z_j + \lambda_i \quad (6)$$

$$Satisfaction = a'_0 + a'_1Regulation + a'_2Accountability + a'_3X_{ij} + a'_4Z_j + \lambda_i \quad (7)$$

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. λ_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,

