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The Quantitative Evaluation of the Political Cost of Environmental Issues: A Case Study of a Typical Public Protest in China

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ABSTRACT

It is of great reference significance for broadening the research perspective of environmental issues, improving the efficiency of government environmental governance and the credibility of the government, to scientifically measure and analyze the political cost of environmental issues. This article takes the typical case “protest event of power generation project of R steel plant in T city, China” as the research background. First, the generation process and action mechanism of the political cost of environmental issues in the actual situation are investigated. Then, through in-depth interview, multi-case grounded theory and fuzzy subordinate function analysis, the scientific construction of the political cost index system of environmental issues are completed. Finally, based on G1 method/entropy method combined with weighting and fuzzy comprehensive evaluation method, the political cost of the protest events of R iron and steel plant in T city is measured. The results show that (1) it is important that good single dimensions and reliable indicators are embodied in the overall political cost scale. Among them, the behavioral political cost of the masses is the largest proportion of all indicators; (2) after the entire environmental mass incident is over, the political costs are difficult to repair, and some lagging ideas and behaviors shown by local governments lead to a continuous expansion of the political cost associated with environmental issues; and (3) local governments should not conceal information asymmetry. Instead, local governments should give greater freedom to other actors to deal with environmental problems. This will mitigate the effect of political costs. Corresponding policy recommendations are proposed.

Key words: The political cost of environmental issues, the construction of index system, the grounded theory, the combinational evaluation of subjective and objective method

1. Introduction

In recent years, the government has incorporated the construction of ecological civilization into the overall national construction layout under the concept of balancing economic development and environmental protection, and has included environmental protection indicators into the performance assessment of local leaders and cadres. The environmental protection inspectors have created a strong deterrent effect and raised the status of ecological protection in political discourse. However, the worry is that, with the rapid development of industrialization and urbanization, the industrial structure in some areas is still unreasonable and pollutants continue to exceed the standard emissions, which leads to heavy pollution [1]. Furthermore, the rapid increase in the urban population has meant that “stigmatized”¹ facilities are beginning to be widely used in public life. These facilities are often public welfare facilities, but they can have a “negative” impact on neighboring residents, which brings a series of new problems and conflicts [2]. In addition, some local government environmental governance systems and environmental spatial planning have certain defects, which lead to a “cost-benefit”

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¹“Stigmatized” projects refer to some facilities that can meet the production and living needs of citizens and bring social welfare, but at the same time have certain negative externalities. These facilities include waste incineration plants, power substations, prisons, crematoriums, and mobile network communication base station facilities.

imbalance in the supply of environmental public goods [3]. These phenomena will reduce the credibility of a government, public recognition and satisfaction, and even cause public resistance and conflicts [4], resulting in an unnecessary waste of political resources. This loss of political resources and its political impact on various interest groups form the political cost of environmental issues. In particular, the ability of a government or authority to govern is challenged and the government is forced to respond passively to various problems through the process of environmental governance and by institutionalized means in order to remove local ecological crises under the condition of “lagging” perception. In addition, the development of political democratization, and the increase in public participation and awareness of environmental rights have meant that public understanding of political costs has gradually changed from abstract, absolute, and passive to concrete, realistic, and active, and the status of political costs associated with the measurement of environmental governance quality and effectiveness has gradually increased. Therefore, when considering environmental governance, attention should be paid to the excavation, measurement, and effective use of political costs because attention to these issues will highlight deep-seated and hidden problems associated with environmental governance, enhance the quality and effectiveness of environmental governance, improve the coordination mechanism for socio-economic and ecological civilization, and promote modernization of the national governance system and governance capacity.

The coercive characteristics of the government system mean that there is a lag in the governance model response to the current situation, institutional discrimination, uneven distribution of government public goods supply and benefits, and procedural inequity. These problems may trigger resistance by the subjects of interest [5]. The process of environmental governance is essentially a process of maximizing the interests of all interested parties [6]. The government, as the institution that ultimately allocates resources, needs to comprehend considerable amounts of information and conduct a scientific analysis of environmental governance when governing the environment, and convene relevant experts to discuss and scientifically evaluate the feasibility and operability of various options. It also needs to assess the risks, public opinion, and benefits associated with implementing a certain option [7]. When the validated decisions are put into practice, the waste and loss of political resources caused by unscientific decisions can be avoided. In addition, the process of consuming political resources related to environmental concerns is accompanied by complex issues, such as political ethics, government and citizen behavior, and political legitimacy [8]. The 40 years of reform and opening up have led to profound changes in China's social structure and economic system. Complicated interest demands and diversified social classes have emerged [9], and the original interest pattern and economic and social structure of some heavy chemical and resource-dependent cities have been broken, all of which make it difficult for traditional governance approaches to effectively deal with multiple conflicting interests in environmental governance [10]. At the same time, China's environmental governance lacks a dedicated institution or a collaborative mechanism to plan and promote “multifaceted shared governance” [11], which means that the political costs of environmental issues are often high. A corroborating fact is that during the protests against waste incineration power projects in Beijing Aswei in 2009 and Xiantao in Zhejiang in 2016, the public first defended their rights and expressed their interests by reasonably expressing their demands. However, due to mishandling by local governments, the low governance capacity of some public officials, and individual local departments who were fighting for themselves and maintaining stability first, the environmental demands of the public could not be effectively resolved. This has led some members of the public to start defending their rights by illegal and irregular means, which has led to an outbreak of environmental mass incidents. The interests of the public and other governing bodies have led to the selective distribution of environmental public goods and the fine-grained disposition of political resources, which has meant that political costs are constantly associated with the expression of public demands or the occurrence of protests. The study of the political costs associated with environmental problems requires multidisciplinary theories and methods, such as public crisis management, government economics, and social security, but it also should pay attention to obtaining control instruments from a multi-disciplinary and multiple-research perspective [12]. Considering and measuring political costs together with other costs, such as economic costs, within environmental governance performance and as variables for evaluating government efficiency will substantially improve environmental governance efficiency [13].

2. Definitions and literature review

2.1. The definition of the political cost of environmental issues

The issue of environmental governance has become a political issue and an important part of the political life of many countries [14]. The introduction of political science, public administration, and economics in environmental governance are conducive to broadening the connotation and extension of

environmental governance, which can help the government to determine an effective and precise path with respect to environmental management. In 1844, French engineer J. Dupuy proposed that governments should adopt the idea of cost-utility analysis in relation to administrative execution and the “Utility Measurement of Public Works”. With the increasing diversity and complexity of public affairs, the importance of the cost of governance in the government is a concept that has emerged repeatedly. In his trilogy of political systems theory, American scholar David Easton (2001) proposed that, for a political system to function properly, it must have some resources to serve as a driving force and foundation [15]. This was also the first time that political scholars introduced the concept of political resources [16]. Harold D. Lasswell (1982) and Dennis Lang (2001) subsequently continued to deepen the interpretation of the concept of political resources, arguing that elements such as the institutional mechanisms of politics, political organization and culture, and external governance structures of politics are a political means to influence political objects that can be constantly consumed and lost [17,18]. The government needs to have and consume certain resources (e.g., the means and methods used by political entities to influence and act on political objects), which constitute political resources, in order to exercise political power and governance behavior, and which thus reflects the value of its existence and achieves its governance goals [19]. The cost of government governance refers to the sum of various human, material, and financial resources invested and generated by the government in order to obtain governance performance. It can be divided into “tangible resources” (e.g., economic resources), which are materially consumed, and “intangible resources” (e.g., political resources), which reflect the authority and legitimacy of the government. Due to the hidden characteristic of intangible resources, they are often ignored by the government [20]. In addition, intangible resources also exist objectively, and are constantly used and consumed by the government or political parties within the context of their political activities, examples of which include organizational resources, the concept of democracy, and governance advocated by the government, in the organizational structure of government [21]. Therefore, a country, government, or political party that values and effectively uses intangible resources will appear more stable in terms of its legitimacy base and political security. Political science scholars took this opportunity to define the connotation of political costs, arguing that society and the administrative system will consume resources, which leads to administrative inefficiency, public policy failure, or other problems, and thereby brings about a decrease in public support and identification with the government, government legitimacy, and political authority. The political resources consumed are termed political costs [22,23].

In recent years, the issue of environmental governance has become important in the political system. In its capacity as a governor, the government not only needs to provide environmental public goods, but also needs to use environmental governance resources scientifically to maximize the supply of environmental public goods. The government has invested sizeable financial, human, and material resources to manage the environment and address public incidents caused by environmental problems, which means that many economic, political, and social resources are needed. Norman Myers pointed out that “ecological crises and environmental security are about the political stability of the government and are a fundamental variable in the issue of political stability and social security” [24]. Under the coercive character of the governmental system, institutional discrimination, the uneven distribution of governmental public goods supply and benefits, and unfair procedures will trigger protests by various interest entities. For example, during the protests that took place against waste incineration power projects in Asuwei, Beijing in 2009 and Xiantao, Zhejiang in 2016, and the explosion of a chemical plant in Xiangshui, Jiangsu in 2019, the public first defended their rights and expressed their interests by reasonably expressing their demands. However, due to mishandling by local governments and the low governance capacity of some officials, it was not possible to effectively address the public’s environmental demands. As such, some people started to defend their rights by illegal and irregular means. Therefore, the number of illegal petitions and lawsuits significantly increased, and this situation is highly likely to result in an outbreak of environmental mass incidents. The interests of the public and other governance entities have led to the selective allocation of political resources, which means that neglect in the area of political costs is constantly visible and expressed by public demands or the occurrence of protest events [25].

Based on the above analysis, the political costs of environmental issues can be understood as the political resources that are consumed by the government as well as the political costs that are borne by society, organizations, or others in the process of exercising political power and taking political measures in order to achieve environmental governance and meet the public demand for a better living environment. Political costs not only refer to intangible and scarce resources which are difficult to acquire and accumulate, but they also belong to a special type of cost, which means that they are difficult to repair once damaged. Specifically, political costs contain the following elements: 1) In environmental governance, local governments use various institutional political resources, such as

institutional systems and policies and regulations, to regulate and constrain the relationships and behaviors among various governance entities. These laws and policies belong to the institutional system of environmental governance, and the institutional political costs of the government to achieve the governance of environmental problems and environmental sustainability [26]. 2) The implementation of policies and systems promulgated by the nation regarding the governance of environmental issues requires the participation and implementation of the government [27], social organizations, and relevant staff. These governance organizations and staff together form the system of political organization that guarantees the effective functioning of environmental governance, which is the organizational political cost of environmental issues. 3) The political system must contain a certain value cognition system, since the modern governance is a political behavior guided by certain value concepts and cognition. This value cognition system is referred to as a socially perceptive political cost, which not only includes publicity and education resources that are necessary for the long-term behavior of social entities to produce a political identity, but also the government vis-a-vis the propaganda and education system that is designed to enable the social public to form ideals and beliefs, moral codes, legal consciousness and a social mentality that are compatible [28]. 4) The current environmental pollution management problems and the continuous occurrence of environmental mass incidents have a negative impact on public rights, property, mentality, and public political perceptions and attitudes, while public satisfaction, political identity, and political trust are also expressed through the public's political behaviors. At the same time, the management of environmental problems and environmental mass events is a complex and long-term systemic project that requires long and uninterrupted public participation and support, and therefore also includes mass behavioral political costs [29].

2.2. Literature review

In recent years, most researchers have focused on research that explored how the pollution crisis could be dealt with effectively, how to prevent pollution, and how to improve the environment. The first issue relates to an analysis of the causes of pollution. Academic research generally aims to analyze the inherent reasons for environmental pollution problems, such as public awareness and participation in pollution control, the different interests of various governance entities, and the traditional ethical norms of rural communities, all of which affect the level of environmental pollution control. Therefore, environmental problems in a region should also be considered in relation to social perception [30-32]. The second issue relates to environmental governance approaches. Researchers believe that social organizations play a very important role in environmental governance. At the same time, they also believe that the current environmental emergency system is somewhat weak and that the management system is not perfect. In addition, there is a lack of respect for the technical support system. Good governance in this area can only be achieved by developing a multi-centered model of environmental governance. Effective and comprehensive ecological improvement can be brought about by encouraging coordination among inter-regional governments. Furthermore, the environmental governance carried out by local officials can be improved by using a performance incentive mechanism (promotion). Moreover, environmental governance should be subject to audits and policy evaluations, which should be actively carried out throughout the whole process, and an emphasis should be placed on the role of rural elites in environmental governance. Last, but not least, environmental problems should be resolved by adopting a perspective that focuses on improving the ability of governments to carry out ecological environmental governance [33-36]. The third issue relates to the research methods associated with environmental governance. Researchers optimize current environmental governance policies and measures based on the level of coordination and the relationships that exist among the multiple parties engaged in environmental governance, such as the government, society, enterprises, and the public. Commonly used analytical models include the coordination model, the social network model, the evolutionary game model, the cooperative game model, and the differential game model [37-40]. Finally, researchers are also actively involved in exploring environmental risk governance. Jürgen and Bruce (2007) believe that it is essential that relevant institutions incorporate effective, timely, and comprehensive communication methods into the area of environmental governance in order to respond to the emergence of a situation that poses an environmental risk [41]. At the same time, Rajesh (2019) constructed an interpretative framework for environmental risk [42]. Furthermore, Yamashita (2015) discussed the importance of communication mechanisms between the government and the public with respect to environmental risk governance [43]. In addition, Nakazawa (2018), Richard and Nikolaos (2017), and Patrick (2011) suggested that the government should establish a two-way communication mechanism and perfect a risk assessment mechanism with the public [44-46]. At the same time, the transparency of various environmental assessments should be enhanced, including public meetings and website voting, so as to reduce the negative cost of “NIMBY”- or “Not in My Backyard”-effects incurred by society.

From the perspective of public choice theory, the government, as a rational economic person and agent, has to provide necessary ecological public goods to the public. During the process of governance, the government will continuously incur various “transaction costs”, which means that it may not be able to take care of other interests, such as enterprises, in a fair manner. Each interest will influence the formulation of environmental policy through various channels to achieve the final balance in environmental policy. The process of environmental pollution control involves too many interests and too many conflicts of interests, and environmental pollution control itself has externality [47]. This means that interested parties constantly seek to maintain their own interests. Furthermore, their own interests and demands may interfere with the optimality of the policy [48], which means that the corresponding measures cannot be thoroughly and effectively implemented, thus causing the consumption of limited political resources in environmental governance. Therefore, there is an urgent need to establish a reasonable political cost control mechanism that will increase the effectiveness of policies, improve the public perception of environmental governance and governance expectations, enhance public trust, and reduce negative externalities. However, neither academics nor political circles have established a targeted and systematic evaluation index system and measurement tools for the political costs of environmental issues. Most researchers have analyzed the economic cost of environmental governance or the cost of government regulation from the aspect of “cost-benefit”. The study of the political costs of environmental governance is still in its infancy, the measurement of the political costs of environmental governance is only at an early stage, and there is a lack of field research and empirical analysis in the form of scale development and testing. Therefore, this study mapped political cost attrition to a specific field of governmental governance process by combining typical case examples of environmental governance in China. At the same time, based on the concept and characteristics of political cost, this study adopted multi-case rooting theory and fuzzy affiliation evaluation to complete the scientific construction of a political cost of environmental issues index system, which turned the political cost of environmental issues into an observable variable or outcome variable. In a case study, the political cost of “the protest against the R steel plant in T city” was measured using the G1/Entropy combination weighting and the fuzzy comprehensive evaluation method, so that the government could perceive the political cost at each stage in time and introduce or adjust relevant policies and governance programs in a timely and scientific manner.

3. Construction of the measurement index system

The construction of a political cost of an environmental issues index system is a complex, systematic project, and the selection of a suitable method is a key part of system construction. It is also important to ensure the scientific basis, operability, and measurement quality of the index system. In addition, it is difficult to quantitatively measure the political costs of environmental issues using a single, quantitative, statistical instrument because of the difficulties associated with a quantitative analysis, such as public approval and support. However, since the political costs of environmental issues also have input and output functions and some relevant variables have measurability, they can be assessed using macro data analyses, social surveys, public opinion support and satisfaction tests, public opinion observation, and other measurement tools [49,50]. In view of this, the construction of a political cost of environmental issues index system is based on the following principles: the first is the principle of operability. When the indicator system is selected, it should be guided by relevant theories and existing cases about the political cost of environmental issues to ensure that the measurement indicator system is logical and reasonable, that the evaluation is comprehensive and credible, and to make it operational and reliable. The second is the principle of comparability. The selection of the indicator system involves a comparison of different regions, different time periods, and different stages of the indicator system with each other. Therefore, when establishing the indicators, comparisons need to be made between regions or different time periods within the same region so that the indicators are representative and typical. The third is the principle of hierarchy. The political cost of environmental issues involves a variety of structural linkages. The intersection of different fields and interdisciplinary synergies mean that the design of the indicator system needs to be coordinated in terms of classification standards and caliber of indicators so that the operational procedures of the evaluation objectives are understood at a general level, the main and secondary indicators should be clarified, the indicators should be interlinked and complementary to each other, and special and qualitative indicators should be scientifically based so that the statistical data are valid[51]. The fourth is the principle of combining subjectivity and objectivity. Qualitative or quantitative indicators with clear conclusions should be identified through testing, surveys, and reviews [52], and the indicators should improve the collection and gathering of specific data so that the indicator system can objectively and truly reflect the consumption of political costs associated with environmental issues in order to ensure the validity of

the evaluation. Based on the above principles, this study selected sample events that provided the largest amount of information about the measurement of the political cost of environmental issues in order to facilitate field research, data collection and in-depth analysis. The specific criteria were as follows: (1) the whole environmental governance event should be longitudinal in time, i.e., it should contain a complete and clear evolution of the political cost of environmental issues. (2) It should meet the purpose and requirements of the study. In the case of environmental governance, the government, enterprises, social organizations (media), the public, and other governance subjects should interact in a hierarchical ladder, and the various elements of the political costs can be fully displayed. (3) The selected environmental governance case should include a wide range of recent public opinion and social influence, and the information available for investigation and research should cover the issues to be studied as much as possible.

Based on these criteria, this study selected the power generation projects at the R steel plant in T city that lasted for nearly 7 years (2013–2019). The projects included air haze control and the construction of waste incineration thermal power. There were sudden environmental protests, and three other public action stages. The R steel plant was the main sample that was analyzed and seven typical cases of environmental pollution control with high impact and attention in China were considered as supplementary samples. The seven selected typical cases of environmental pollution control were randomly divided into two groups, one of which was used to extract the measurements and the other to test the measurements (Table 1).

Table 1

Sample cases of political cost studies on environmental issues

Case sample name	Use in this study	Sample Case Name	Use in this study
Cadmium pollution incident in Liuyang, Hunan (2003)	Screening Indicators	Waste incineration plant construction project incident in Asuwei (2009)	Inspection index
Cyanobacterial crisis events in Taihu and Chaohu Lakes (2007)	Screening Indicators	Anti-sewage project incident in Qidong, Jiangsu (2012)	Inspection index
Haze pollution control in the Beijing-Tianjin-Hebei region (2017)	Screening Indicators	PX project incident in Maoming, Guangdong (2014)	Inspection index
Chemical plant explosion in Ringshui County, Jiangsu (2019)	Screening Indicators		

“The protest against the R steel plant power generation project in T city” is a typical case of governance from environmental pollution at the beginning to risk avoidance and finally to environmental protest, and its development process represents a microcosm of environmental risk management events nationwide. From November, 2017 to March, 2018, persistent hazy weather often affected T city X town, which is located in the southeast of T city on both sides of the Sha River, includes X village, Y village, S village, L village, and other administrative villages. It is a provincial top 100 township and is dominated by heavy industries, such as steel and machinery, of which the steel industry is led by the R steel plant. In the first half of 2018, the town paid 1615.76 million yuan in state taxes. Small and medium-sized factories and stores are clustered in the villages around the R steel plant. The residents of X town in T city have a high incidence of upper respiratory tract infections, so “haze” has become the number one concern for local residents on a daily basis. In February, 2018, the 100 MW ultra-high temperature sub-critical gas and incineration power generation project at R steel plant was completed, which is located in the yard of the R steel plant, a short distance away from Y village. During the construction process, the impact of construction dust and air pollution led to villagers from the surrounding villages expressing their complaints and questions in various ways. Then, in June 2018 (wheat harvesting season), the power generation project emitted rolls of black smoke due to technical worker operational errors which choked the villagers with its smell as the dust drifted down onto their clothes and the wheat drying in their yards. This directly led to sudden upper respiratory allergies in dozens of people and triggered an environmental mass incident at the R Steel Plant in X Town, T city. (Villagers from surrounding villages petitioned the X Town government through demonstrations, road blocking, and other protests.), which led to the shutdown of the R Steel Plant power generation project. However, one month after the incident, the power generation project was restarted after active

management by the local government and with a villager support rate of 90%. After reviewing the data and following an investigation, a report found that “the protest against the power generation project at R steel plant in T city” was one of the more representative incidents of environmental pollution and conflicts in China. This study investigated the entire environmental mass events process by analyzing the political cost of the events under the guidance of root theory. It then clarified the key elements associated with the political cost of environmental issues and extracted these key elements to derive some measurement indicators.

In order to further develop a political cost indicator system for environmental issues, field research and data collection were carried out in strict accordance with a set plan and procedures: Step 1– before beginning the field research, a large amount of information was collected and case screening was conducted to identify the objects to be researched. This included using the Internet (search engines, WeChat, Tik Tok, posting forums, microblogs, QICQ groups, etc.), databases (CNKI, WEB-SCI, SCI-Direct), and the telephone to collect relevant secondary information (see Table 2). Step 2– the research plan was formulated and the field research was conducted. In order to prevent some unnecessary factors from interfering with the research, such as interference by the “gatekeeper”¹, the role of the “insider” was adopted. The participant was observed and allowed to interact with the respondents and interviewers in a participatory manner so that they relaxed their vigilance and lowered their guard, and to ensure that the objectivity and authenticity of the research. Step 3– The interviews were recorded, with the consent of the interviewees. Face-to-face in-depth interviews and symposiums, as well as a combination of semi-structured and focus group interviews, were used. This facilitated the organization and coding of the original interview data (Table 3a), and relevant primary data were collected after interviewing experts, government public officials, and members of social organizations who had studied, participated in, or paid attention to the seven typical cases selected (14 interviews were conducted, and about 16,000 words from interview scripts were compiled) (Table 3b). Step 4– With the help of ATLAS.ti8 software, the literature and research data were summarized and coded. A system for political cost indicators for environmental issues was derived by assigning the “political cost concept” to the data.

Table 2

Research data collection

Access to information	Source	Main contents	Quantity	Date of publication
Baidu/Google: news, reviews, interviews (D1)	Sina-Blog, Phoenix Finance, T-Government.com, etc.	Development background and the practices of government and the enterprises, nodal events, media commentary, expert views	116	2002.9-2018.7
CNKI, WEB-SCI, SCI-Direct (D2)	Periodicals	Various domestic environmental protest events, haze management studies and an EIA analysis in Beijing-Tianjin-Hebei region, environmental technology studies of power generation projects, etc.	372	2002.1-2018.6
WeChat/Tik Tok/Posting forum/ QICQ group (D3)	Silent Spring public website, T city environmental protection public website, X town's posting bar, Y people in R plant and other QICQ groups	Attitudes of local governments and enterprises, official reports, protest strategies and behaviors, media-related analyses, perception of environmental risks, etc.	719	2017.10-2018.8

¹ A gatekeeper is a person who has authority over the researched person. The gatekeepers include the head of the environmental protection unit and the director of the finance office for X town government, the secretary of X town and the X village committees, and the manager of the project department at the R steel plant. When arriving in X town in early November, 2017 to try to understand the situation from villagers and workers, we were interfered with by the village committee, the steel plant security guards, and the town government's general government office. It was only after three days and an introduction letter from the environmental protection department in T that the investigation could be launched and was conducted in stages, while the interviews and questionnaires were kept close to reality by spending large amounts of money.

Collected through field observation	Villagers provide, observation records	Observation records, research reports, local materials, etc.	15	2017.12, 2018.2, 2018.6
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Table 3a

Basic information about the interview

Interviewees (Coding)	The form of interview	The length of interview (duration)	Length of the interview (word count)
Villager A1, A2, A3 of Y village	Semi structured interview	3 hours	3010
Villager B1, B2, B3 of X village	Semi structured interview	1.5 hours	2671
Citizen F1 of F county	In-depth interview	2 hours	2246
Citizen X1, X2 of X town	Semi structured interview	2 hours	2870
Staff C of T municipal government Staff member W of the Environmental Protection Bureau of District F Staff C of X Township Government Staff J of R steel plant	Symposium and interview focus groups	3 hours	5742

Table 3b

Information related to expert interviews

Case sample name	Department	Data collection method	Duration (hour)	Word count
Cadmium pollution incident in Liuyang, Hunan (2003)	Academy of Social Sciences	In-depth interviews	1	1452
Cyanobacterial crisis events in Taihu and Chaohu Lakes (2007)	High School	In-depth interviews	1	1533
Haze pollution control in the Beijing-Tianjin-Hebei region (2017)	Research Institute	Symposium	1	1769
Chemical plant explosion in Ringshui County, Jiangsu (2019)	Government Department	Symposium	1.5	2667
Waste incineration plant construction project incident in Asuwei (2009)	College	In-depth interviews	1.5	2410
Anti-sewage project incident in Qidong, Jiangsu (2012)	College	In-depth interviews	2	3158
PX project incident in Maoming, Guangdong (2014)	Government Departments	Symposium	2	3477

3.1. Open coding

With the help of ATLAS.ti8 analysis software, the primary textual information from several typical cases was collected and transcribed to be decomposed. In order to check the authenticity, completeness, and accuracy of the sources of the interview recordings and research data, the data were labeled (zx), formed into primary codes (ZZx), codes (Zx), and finally into open-ended codes (Dx). The same or similar elements existing in the primary information and the primary indicator system were retained, and the more occurrences, the more meaningful the phenomenon represented by the label. A total of 191 primary codes, 87 codes, and 25 open codes were collated and formed, and the relationships between the open codes for the political cost of environmental issues were juxtaposed with each other and their functions, and processes were obtained (see Table 4 for the open code formation process). After coding, a total of 38 open codes and 10 main axis codes were obtained for the political cost of environmental issues measurement index system. An initial system (consisting of 1

primary indicator, 4 secondary indicators, 10 tertiary indicators, and 38 quaternary indicators) was established that was decomposable, independent, comprehensive, and easy to operate.

Table 4

Example of the open coding process for the political cost of environmental issues indicator system (excerpt)

Open coding (conceptualization)	Code (Z _x)	Primary code (ZZ _x)	Original information about the case (Z _x)
Degree of effectiveness of enacting policies and regulations at certain phase of the protest process (including regulation, governance measurements, benefit compensation, etc.) (D ₁)	Large number of policies introduced during the period (Z ₂)	Regulation, governance measurements, standards, benefit compensation and other policy measurements continue to improve (ZZ ₅)	Beijing, Tianjin, and Hebei have issued a “Three-year action plan for the defense of blue sky” and a “Notice on the implementation of environmental protection deadline for key areas and key polluting enterprises in the city”; Hebei Province has issued a “Notice on continuous good environmental protection”; Jiangsu Province has issued the “Implementation standards for major pollutant emissions in key industries and regions”; and Hunan Province has issued a “Notice on accelerating the relocation of air pollution enterprises.” (Z ₁₃) “Public complaints about this incident were handled fairly smoothly.” (Z ₄₁)
Degree of closure of telephone/internet complaint cases within the phase of the protest process (D ₉)	Inconsistency in the extent of case handling (Z ₁₈)	Slow processing speed has led to a decline in credibility (ZZ ₄₃)	“We still have blind spots in supervision, and it is often difficult to monitor so it delays the speed of case completion.” (Z ₃₉) “I think some of the complaints are making a show whether it is the government or the companies.” (Z ₄₃) “The deputy secretary of the party group of the Environmental Protection Bureau in Liuyang City was removed from his post and the deputy mayor involved was transferred to the judicial authorities.” (Z ₁₀₃)
Degree of public official accountability (D ₂₂)	The depth of the degree of punishment for accountability (Z ₄₅)	The heads of enterprises, government officials, etc. associated with the creation of pollution have been criminally prosecuted, suspended, etc. (ZZ ₁₀₅)	“In our research, we found that some polluting enterprises have transformed themselves into high-tech enterprises and energy-saving technology enterprises through ‘fine packaging’ to avoid pollution problems. Enterprise “greenwashing” behavior was spared by some local governments, which is undoubtedly a distorted view of political performance.” (Z ₁₀₄) “In this pollution incident, we implemented administrative accountability for 26 government staff, 12 of whom were removed from their posts.” (Z ₁₀₁)
Perceived fairness of the interaction (D ₂₄)	The perceived fairness of government and public response attitude during the process of conflict resolution (Z ₅₂)	Interpersonal equity refers to the extent to which the public is respected and cared for by the government, enterprises, etc. (ZZ ₁₂₁)	“Local governments around Taihu Lake and Chaohu Lake promote the solution of the problem through public announcements of environmental assessments, symposiums, and household visits.” (Z ₁₁₉) “I’ve been kicked around by phone calls and emails.” (Z ₅₆) “Our governments all convince people to understand the government and invite them to watch the construction through face-to-face dialogues.” (Z ₁₈₂)

Open coding (conceptualization)	Code (Z _x)	Primary code (ZZ _x)	Original information about the case (Z _x)
Public opinion collection and departmental transfer capability (D ₂₆)	The transmission, interoperability and sharing of information and materials between departments (Z ₅₆)	Collect and sort out network public opinion, and report the collected information to other departments, so as to formulate relevant collaborative countermeasures (ZZ ₁₂₉)	<p>“The tendency of the government to interact with property owners in a multi-dimensional and proactive manner.” (Z₁₁₅)</p> <p>“My petitions at the municipal health bureau were stoned and I had to wait for a long time every time I went there; at the municipal land and resources bureau, these petitions were even mocked by the head of the bureau.” (Z₁₁₃)</p> <p>“Government departments are now establishing an early warning mechanism for online public opinion to understand the real-time development of mass incidents.” (Z₈₀)</p> <p>“The local government is controlling online public opinion in a timely manner, and collaborating with the propaganda and Internet information departments to guide and educate on rumors.” (Z₁₃₁)</p> <p>“Exposure in new media and self-media is higher and the local government does not take note of the information.” (Z₁₂₈)</p>
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Note: Due to the excessive length of the analysis involving 191 primary codes, the excerpts are presented as additional indicators not presented in the previous section

3.2. Associative codes

The political cost of environmental issues indicator system is a multi-level and multi-factor composite structure. Starting with the original concept, this study conceptualized and simplified it by combining previous relevant studies at home and abroad. The system was first divided into two levels: the first level indicator was the total measurement target-political cost of environmental issues; and there were four second level indicators, i.e., institutional political cost, organizational political cost, social perceived political, cost and mass behavioral political cost. On this basis, the meaning and relationship of each main axis code were reorganized to form four relatively independent core categories and 10 corresponding main axis codes (see Table 5 for details).

Table 5
Associative codes

Core categories	Main axis coding
The institutional political cost of environmental issues (B ₁)	Validity of institutional tools (C ₁) Validity of system implementation (C ₂) Government credibility and implementation (C ₃)
The organizational political cost of environmental issues (B ₂)	Competence level of public officials (C ₄) Integrity level of public officials (C ₅)
The social perceptive political cost of environmental issues (B ₃)	Perception of social equity (C ₆) Effectiveness of public opinion regulation (C ₇) Social risk perception (C ₈)
The mass behavioral political cost of environmental issues (B ₄)	Implicit Political Behavior of the Masses (C ₉) Explicit political behavior of the masses (C ₁₀)

3.3. Indicator amendments

This study followed the scale development procedures of Dunn (2020) [53], Churchill (2021) [54], and others, and combined qualitative analysis methods with scale development testing methods to design questionnaire items, thus ensuring the scientific and objective nature of the assessment. At the same time, the indicators for the political cost of environmental issues were revised to solve the

problems associated with a large number of indicators, weak generalizability, vague semantics, lack of operability, and an inability to adapt to changing environmental situations. First, using the expert survey method, this study selected 32 experts, government officials, and members of social organizations who have been engaged in environmental governance and public crisis management research fields for many years from the regions where typical cases of environmental governance have occurred. The initial index system was constituted as an expert screening questionnaire for the political cost of environmental issues measurement index system. Through a combination of in-depth interviews and expert symposiums, experts and researchers in relevant fields were invited (from universities, research institutions, government agencies, social organizations, and other institutions) to select the indicators they considered the most important for the political cost of environmental issues index based on their own academic knowledge and research experience. The aim was to understand their views and opinions and collect constructive opinions. A total of 32 copies of the expert screening questionnaire were returned, of which 30 were valid, and the questionnaire recovery rate and efficiency rate were above 93%. The basic information statistics for the experts are shown in Table 6 (a). After distributing the questionnaires to collect the survey data, this study undertook a redundancy analysis of the information given by the experts, refined the summary, and used fuzzy statistical analysis to eliminate the measurement items with low affiliations to finally determine the formal measurement index system.

Given that the political cost of environmental issues is a fuzzy concept, the political cost of environmental issues indicator system was also considered to be a fuzzy set: $\{Y\}$ was defined as the indicator set, i.e., each indicator in the indicator system was considered to be an element in the set, and then the expert survey method was used to conduct the indicator affiliation analysis and calculate the affiliation of 38 indicators of the political cost of environmental issues. Based on this, we were able to determine whether to keep them in the political cost of environmental issues index system. Assuming that the total number of expert confirmations for the i -th. indicator Y_i is Z_i , i.e., a total of Z_i experts confirm Y_i as an important evaluation indicator for assessing the political cost of environmental issues, and the total number of people measured is 30, then the affiliation degree of the political cost of environmental issues indicator is:

$$R_i = \frac{Z_i}{30} (i = 1, 2, \dots, 30) \quad (1)$$

Whether the measurement index Z_i is taken or rejected depends on whether its membership, R_i , is greater than or less than the critical membership. If it was the former, the measurement index was retained; if was the latter, it was deleted when critical membership = the critical value of expert selection times $Z/30$. Therefore, the critical value of expert confirmation times Z ($\alpha = 0.01$) is:

$$Z = \mu + \frac{S}{\sqrt{Z'}} t_{0.01} = 23.4 + \frac{5.77}{\sqrt{1140}} \times 2.368 = 23.8 \quad (2)$$

In Formula 2, S denotes the standard deviation of the number of expert confirmations, μ denotes the expected value of the number of expert confirmations, Z' denotes the total number of expert confirmations, and $t_{0.01}$ denotes the T -test value at a significance level of $\alpha = 0.01$. An analysis of the data calculation showed that the critical affiliation was 79.4% when the critical value of the number of expert confirmations was $Z = 23.8$. Therefore, when the affiliation degree ($\alpha = 0.01$) of an indicator was less than 79.4%, then the indicator was not statistically significantly different within the political cost of environmental issues indicator system and was removed. Among the 38 indicators measuring the political cost of environmental issues in the thesis, 13 indicators had an affiliation degree less than 79.4%, as detailed in Table 6(b). Thirteen indicators were removed from the 38 indicators in the second round of the indicator system construction process and 25 indicators were retained.

Table 6
Expert screening results and memberships for each measurement

Table (a) Expert information statistics

Project	Category	Proportion
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Project	Category	Proportion
Gender of the expert	Male	63.3
	Female	36.7
Age	26-29 years old	10
	30-39 years old	20
	40-49 years old	43.3
	Over 50 years old	26.7
	Undergraduate	16.7
Education level	Master	40
	Doctorate	43.3
	Government agencies	23.3
Work unit	Research Institutes	16.7
	Universities	50
	Social organizations and other institutions	10
Title	Primary Title	0
	Intermediate Title	26.7
	Deputy Senior Title	33.3
	Senior title	40

Table (b) Selection results and membership of experts

Four levels of indicators, number of expert tick marks, membership values, retention (yes/no) for the political cost measurement of environmental issues	Number of expert selections	Membership function value	Reserved (yes / no)
Degree of effectiveness of policies and regulations enacted during the period (including regulation, governance measures, benefit compensation, etc.) (D ₁)	14	0.47	N
Degree of effectiveness of existing policies and regulations (including regulation, governance measurements, benefit compensation, etc.) (D ₂)	29	0.97	Y
Scientific basis and legitimacy of environmental policy tools (including the degree of expert validation, assessment system, etc.) (D ₃)	29	0.97	Y
Completeness of the emergency prevention and control system (mechanism) (D ₄)	27	0.9	Y
Consistency of system policy and government implementation (D ₅)	28	0.93	Y
Degree of fulfillment and delivery of system policies (D ₆)	28	0.93	Y
Degree of administrative punishment at this level (including interviews, warnings, fines, etc.) (D ₇)	25	0.83	Y
Degree of completion of administrative reconsideration cases received within the period (D ₈)	16	0.53	N
Degree of completion of telephone/internet complaint cases within the stage (D ₉)	26	0.8	Y
Government authority (including regulation, information response, etc.) (D ₁₀)	27	0.9	Y
Image of the government (D ₁₁)	17	0.57	N
Reasonable degree of institutional setup (D ₁₂)	15	0.5	N
Administrative effectiveness (including departmental governance efficiency, degree of interdepartmental synergy, etc.) (D ₁₃)	26	0.86	Y
Level of environmental literacy (D ₁₄)	15	0.5	N
Professional technology and environmental risk assessment capacity (D ₁₅)	28	0.93	Y
Environmental risk emergency response capacity (including research and evaluation capabilities,	30	1	Y

Four levels of indicators, number of expert tick marks, membership values, retention (yes/no) for the political cost measurement of environmental issues	Number of expert selections	Membership function value	Reserved (yes / no)
information dissemination channels, mobilization and decision-making, etc.) (D ₁₆)			
Ability to repair the relationship between the government and the people (communication ability, etc.) (D ₁₇)	27	0.9	Y
Degree of integrity and diligence of public officials (D ₁₈)	28	0.93	Y
Degree of environmental protection enforcement regulation (D ₁₉)	25	0.83	Y
Number of officials involved in corruption as a percentage of administrative personnel (D ₂₀)	14	0.47	N
Degree of accountability of public officials (D ₂₁)	16	0.53	N
Perceived procedural fairness (transparency, etc.) (D ₂₂)	25	0.83	Y
Perceived distributive justice (D ₂₃)	27	0.9	Y
Perceived interactional fairness (D ₂₄)	16	0.53	N
Sensitivity and responsiveness of public opinion (D ₂₅)	17	0.57	N
Public opinion collection and departmental transmission ability (D ₂₆)	27	0.9	Y
Ability to guide public opinion (D ₂₇)	29	0.97	Y
Ability to promote and educate environmental protection theory (D ₂₈)	16	0.53	N
Physiological risk perception (D ₂₉)	29	0.97	Y
Property risk perception (D ₃₀)	17	0.57	N
Psychological risk perception (D ₃₁)	29	0.97	Y
Public satisfaction (D ₃₂)	30	1	Y
Level of political trust (D ₃₃)	27	0.9	Y
Level of political identification (D ₃₄)	15	0.5	N
Level of public participation in environmental petitions within the stage (D ₃₅)	15	0.5	N
Level of public participation in symposiums and hearings within the stage (D ₃₆)	25	0.83	Y
Degree of media access by people within the stage (the number of clicks on environmental governmental platform visits, the number of likes, retweets, and comments on articles related to microblogs, Tik Tok, and WeChat public numbers, etc.) (D ₃₇)	27	0.9	Y
Negative behaviors generated by people during the protest phase (smashing, blocking, fighting, rumor-mongering, etc.) (D ₃₈)	28	0.93	Y

After expert testing and revision, this study finally determined the political cost of environmental issues as a four-level index system with 40 indicators, of which the first-level indicator was the political cost of environmental issues and the second-level indicator contained four points: institutional political cost, organizational political cost, social perception political cost, and mass behavior political cost. Each secondary indicator had corresponding tertiary and quaternary indicators, which consisted of the original 10 tertiary indicators and 25 quaternary indicators identified by the redundancy analysis. In addition, the presentation of some of the level 4 indicators was corrected based on the results of the in-depth interviews (see Table 7).

Table 7

Political cost indicator system for environmental issues after amendments

Primary indicators	Secondary indicators	Tertiary indicators	Quaternary indicators
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Primary indicators	Secondary indicators	Tertiary indicators	Quaternary indicators
Political cost of environmental issues	Institutional political cost of environmental issues (B ₁)	Validity of institutional tools (C ₁)	Degree of effectiveness of existing policies and regulations (regulation, governance measures, compensation of benefits, etc.) (D ₁)
			Scientific basis and legitimacy of environmental policy tools (including the degree of expert validation, assessment system, etc.) (D ₂)
		Validity of system implementation (C ₂)	Completeness of the emergency prevention and control system (mechanism) (D ₃)
			Consistency of system policy and government implementation (D ₄)
	Organizational political cost of environmental issues (B ₂)	Degree of authority and synergy of government departments (C ₃)	Degree of fulfillment and delivery of the system policy (including the implementation of norms) (D ₅)
			Extent of administrative punishment at this level (interviews, warnings, fines, etc.) (D ₆)
			Degree of completion of telephone/internet complaint cases during the period (supervision, information response, etc.) (D ₇)
		Competence level of public officials (C ₄)	Government authority (D ₈)
			Degree of interdepartmental synergy (D ₉)
			Expertise and ability to assess environmental risks (D ₁₀)
	Socially perceived political cost of environmental issues (B ₃)	Level of integrity of public officials (C ₅)	Emergency response capacity of environmental risks (research and evaluation capacity, information release channels, mobilization and decision making, etc.) (D ₁₁)
			Ability to repair the relationship between the government and the people (communication ability, etc.) (D ₁₂)
		Perceived social equity (C ₆)	Degree of integrity of public officials (D ₁₃)
			Degree of diligence of public officials (D ₁₄)
		Effectiveness of public opinion regulation (C ₇)	Perceived procedural fairness (transparency, etc.) (D ₁₅)
			Perceived fairness of distribution (D ₁₆)
	Mass behavioral political cost of environmental issues (B ₄)	Implicit political behavior of the masses (C ₉)	Ability of public opinion collection and departmental transmission (D ₁₇)
			Ability to guide public opinion (D ₁₈)
			Physiological risk perception (D ₁₉)
			Psychological risk perception (D ₂₀)
			Public satisfaction (D ₂₁)
		Explicit political behavior of the masses (C ₁₀)	Political trust level (D ₂₂)
			Intensity of public participation in symposiums and hearings during the stage (D ₂₃)
			Degree of media access by people within the stage (the number of clicks on environmental government platform visits, the number of likes, retweets and comments on articles related to microblogs, Shake, and WeChat public numbers, etc.) (D ₂₄)
			Negative behaviors generated by people during the protest phase (smashing, blocking, fighting, rumor-mongering, etc.) (D ₂₅)

3.4. Confidence validity testing and saturation testing of the coding

Scott's P_i index was chosen as the reliability test when coding the nature of the political composition of environmental issues. Scott's P_i was calculated to be 0.857 (generally, a value above 0.8 indicates good reliability), and therefore the coding part of the political nature of environmental issues analysis was reliable. In order to ensure the validity of the coding and to further test the theoretical saturation of the political cost of environmental issues measurement index system, the same or similar environmental governance cases in China over the last decade were selected for validation. To ensure that the validation process fully followed the aforementioned standardized open coding procedure and the case criteria selected for validation had a strong consistency with the analyzed cases, three typical cases were selected, which were the waste incineration plant construction project incident in Asuwei, the anti-sewage project incident in Qidong, Jiangsu, and the PX project incident in Maoming, Guangdong. One third of the original coding information was used to saturate the indicator system so that an indicator test could be conducted (the information was derived from news reports and research literature, and totaled 6869 words). After coding and a one - to - one analysis, the results showed that the categories in the index system had been edited and enriched, and no new categories or analogous relationships were found, which meant that the system had passed the coding validity test and reached saturation. Thus, the index system for the political cost of environmental issues constructed in this study was scientific and reasonable.

4. Application analysis of the measurement index system

4.1 Selection of measurement methods

The above analysis revealed that the political cost of environmental issues index system was an abstract system and its measurement highlighted the problem of rational social choice and group decision making. The process of social choice and group decision making is based on how group members with common interests, different information, and different decision-making abilities join together to make the best decision [55]. Whether it is through political behavior or public activities, many different social choices and group decisions can play an extremely important role. Therefore, reasonable social choices and group decisions will directly affect the reduction in political cost consumption and the improvement in environmental governance efficiency. In this kind of social choice and group decision process, the attribute values of the measured objects are mostly expressed in the form of fuzzy numbers or interval gray numbers. However, obtaining accurate and reasonable information about the true preferences and attributes of group decision making is often difficult because group utility functions are determined by well-defined individual utility functions [56], which means that assembling individual utility functions into group utility functions is a key aspect of the measurement process. The development of stochastic nonlinear utility and fuzzy decision theory has meant that most studies have tended to use fuzzy mathematical models to “synthesize” multiple evaluation index values into a holistic comprehensive evaluation value, and then obtain group preference relationships and group decision results. The attribute weights reflect the degree of importance that the assessor places on the assessment target, the degree of variation in the values of the assessment indicators, and the degree of reliability of the attribute values for the assessment target [57]. Many methods have been used to obtain attribute weights, such as hierarchical analysis, the entropy method, etc. The multi-objective decision problems of social choice and group decision making can be transformed into single-objective decision problems through the calculation of weights [58]. Attribute weights are also influenced by subjective and objective factors, and reasonable weight assignment methods are needed to improve the accuracy of weight assignment. The fuzzy comprehensive evaluation method refers to the use of multiple indicators based on a fuzzy set with hierarchical rows to make a comprehensive evaluation and classification of the subordinate rank status and change interval of the evaluated object. This method highlights the fuzzy nature of the evaluation criteria and influencing factors, and it can also combine qualitative and quantitative factors in the evaluation. This improves the accuracy and of the evaluation number, which means that evaluation conclusion is credible and thus it is more effective in evaluating complex problems with multiple factors and levels [59,60]. Furthermore, the political cost of environmental issues is a dynamic and comprehensive fuzzy

concept, and is an affiliation vector about multi-level rubrics where the rubric levels are grouped isometrically.

Therefore, this study took the multi-attribute decision problem with a fuzzy number of attribute values as the starting point and used the G1 method to determine the subjective weight coefficients of each indicator of the political cost of environmental issues. At the same time, the entropy weight method was used to determine the objective weight coefficients of each indicator of the political cost of environmental problems. The level values of the political cost of environmental problems and the optimal combined G1/entropy weights of its indicators were determined by the combination method of subjective and objective assignments. Then, the descending semi-trapezoidal distribution method was selected based on the evaluation level of each indicator, the affiliation distribution function was calculated, and the fuzzy transformation principle was used to determine the value of the political cost of environmental problems. This methodology meant that it was possible to clearly and reliably conclude the group decision made by some individuals and judge the real attitudes and choices of actors about environmental problem coping strategies. This meant that the measurement of the political cost of environmental problems had wider non-contingency, applicability and practicality. It could also accurately measure the political costs to the government at each stage of the environmental problem, and then provide a timely reference basis for government decision-making.

4.2 Measurement design and data acquisition

4.2.1. Sample and data collection

The questionnaire¹ about the political cost of environmental issues was designed around the understanding ability of villagers based on the 25 four-level indicators of the index. The questionnaire contained nine items of basic information about the respondents and 25 items that were scored on a seven-point Likert scale, including five items each for the institutional political cost, organizational political cost, social perception political cost, and mass behavior political cost of environmental issues categories. The target of the scale was still the protest about the power generation project at the R steel plant in T city, and it was gradually improved by consulting experts from universities and research institutes in the Beijing-Tianjin-Hebei region, local people, surrounding village cadres, X town government authorities, and R steel plant enterprise managers, etc. The objective weights of the four levels of indicators were calculated from the questionnaire and the political cost to the government of X town in T city when managing the incident was measured. This study questionnaire survey was conducted in two phases according to the development of events, and was carried out in parallel with interviews and resident research. The questionnaires were focused on the four villages around the R steel plant, Y, X, S, and L, and the resettlement community J. The survey was conducted using the random distribution method and face-to-face interviews.

The survey and processing of the first phase of the questionnaire took place between February 1, 2018 and February 11, 2018, and included 803 villagers around the R steel plant (Excluding 129 households who worked outside T city. Due to the completion of the R steel plant power plant many villagers returned to their original work). The survey also contained 674 households living in the village and the town resettlement area (including enterprise managers, but five people who worked for X town government were not included). A total of 400 questionnaires were distributed to meet the sampling requirements, of which 377 questionnaires were collected, with a recovery rate of 94.2%. There were 309 valid questionnaires, which was an effective rate of 82%. During the interviews, we learned that the residents were already very dissatisfied with the emissions and pollution caused by the enterprise because it was involved in the pollution of domestic and agricultural water, and made the surrounding rivers dry up. Air pollution, soil pollution, highway vehicle exhaust emissions, and large vehicle iron slag derived pollution particles also had a considerable impact on village life and agricultural production. However, many villagers were forced to work at the plant and most villagers wanted to put their trust in the local government to govern. At this time, local government governance had led to year on year rises in GDP and tax revenue, which meant that environmental protection supervision by the local government was limited and the resulting environmental pollution potential and social risk potential was relatively large.

¹The questionnaire items should be phrased in simple language and terminology as much as possible, although there are still a few measurements that are more difficult to simplify. In this study, we used semi-open-ended surveys during the field research and interviews, and explained the relevant indicators in person when the interviewees filled out the questionnaire.

The second phase of the survey and processing of the questionnaire took place between July 1, 2018 and July 9, 2018. In this phase, there were 809 village worker households around the R steel plant (the number of new households had increased by six households due to marriage and relocation), but 122 households working outside T City (due to the completion of the R steel plant power generation project, many villagers from the surrounding villages returned to their original jobs) were excluded. There were also 687 households living in the village and town resettlement area (including the enterprise managers, but excluding five people of X town who were government staff). A total of 400 questionnaires were distributed to meet the sampling requirements, of which 369 questionnaires were collected, which was a recovery rate of 92.2%. There were 311 valid questionnaires (the degree of agreement with the respondents in the first stage was about 96.3%), which was an effective rate of 84.3%. At the time of the interviews, it was learnt that the villagers had taken part in neighbor conflicts over the previous two weeks due to the serious exceedance of air quality standards and the air odor throughout the day, which triggered media (social organizations) and other reports. The local government then activated the emergency response plan and collaborated with various departments and the R steel plant to deal with the neighbor conflicts. Afterwards, the government began to strengthen its supervision of the R steel plant and to study the introduction of governance measures and the penalty measures. The R steel plant, at the request of the local environmental protection, civil affairs, land, and financial government departments, began to increase investment in technological improvements and the introduction of environmental protection facilities. They also compensated villagers for any environmental problems (according to the number of acres of land and the number of rural household members). At the same time, it raised the wages of villagers working at the plant and leased agricultural arable land in the surrounding villages for transfer. In addition, the plant has built ecological gardens on the polluted arable land, which are not only gradually eliminating hidden dangers, but also reducing the political cost consumption.

4.2.2. Reliability testing of the questionnaire data

Given the duplication of measurement processes in the two questionnaire phases, the first phase of the research questionnaire and data were selected to analyze the process of assigning and measuring the political costs of environmental issues. Prior to each phase of the formal survey, a pretest was conducted to ask whether the subjects could clearly understand and easily respond. Then, the questionnaire was revised in several rounds until it showed good internal validity. The Cronbach's α values for the four measurements of the political cost of environmental issues of the questionnaire study were 0.728, 0.726, 0.714, and 0.702, which showed that the measurements had excellent reliability levels. The scale was purified using the Corrected Item-Total Correlation (CITC). Question items with a CITC value of 0.5 or below were considered less relevant to the overall results. If Cronbach's α increased significantly when these question items were deleted, it was decided that these questions should be deleted to achieve scale purification. The results showed that all 25 question items passed the test, that is, the Cronbach's α coefficient of each indicator was greater than the critical value of 0.6, which meant they were highly reliable and there was no need to delete any question items. The validity test of the questionnaire used in the first questionnaire phase analysis used the Kaiser-Meyer-Olkin (KMO) measurement and Bartlett's sphericity test. After testing, the KMO values of four of the indicators were greater than 0.6, and thus the questionnaire had significant structural validity. The Bartlett's test of significance was 0.000, and the significance expression met the requirements, so the questionnaire had high validity and could be used for objective weighting and the measurement of the political costs of environmental issues.

4.3 Combination of subjective and objective empowerment and fuzzy measurements

4.3.1. Subjective and objective combination of empowerment

1) G1 method to determine the weights of the measurement indicators

The G1 method improves on the AHP (Analytic Hierarchy Process) method by getting rid of the constraint that decision makers must construct a judgment matrix when judging the scheme, avoids the disadvantage that it is difficult to meet the consistency requirements of the AHP method, and fundamentally solves the consistency problem of individual judgment. Furthermore, the G1 method does not need a consistency test. This method is especially suitable for weighting large scale index systems with many factors. Therefore, the G1 method was selected for the subjective weighting.

In this study, seven experts who have been engaged in the research fields of environmental governance and public crisis management for many years were invited. After judging the relationship of each indicator to the political cost of environmental issues, their importance was assigned as follows:

Let $x_1, x_2, x_3, \dots, x_m$ ($m \geq 2$) be m extremely large indicators that have undergone uniformization and non-dimensionalization of indicator types.

Definition 1: If the importance of index x_i relative to a certain evaluation criterion (or target) is not inferior to x_j , it is recorded as $x_i \geq x_j$ (the symbol $\geq$ indicates that it is not an inferior relationship).

Definition 2: if index $x_1, x_2, x_3, \dots, x_m$ has a relationship with an evaluation criterion (or objective) then it is said that the evaluation indexes $x_1, x_2, x_3, \dots, x_m$ have established an order relationship according to “ $\geq$ ”.

For the evaluation index set $\{x_1, x_2, x_3, \dots, x_m\}$, the order relationship can be established according to the following steps:

Select the most important or least important of the m indicators and mark it as x_i ;

Select the most important or least important indicator among the remaining $m-1$ indicators and mark it as x_j ;

Select the most important or least important indicator among the remaining $m-(k-1)$ indicators and mark it as x_n ; Mark the remaining indicator as x_k .

After determining the only order relationship, the next step is to determine the importance of adjacent indicators.

Under the selected scale, the rational judgment of the selected experts on the importance ratio w_{k-1}/w_k between adjacent indexes x_{k-1} and x_k is derived as follows:

When the number of indicators is large, the most minor indicator $r_m = 1$ can be used and the r_k value can be derived from Table 8.

Table 8

The scale

r_k	Definition
1.0	Indicator x_{k-1} is as important as indicator x_k
1.2	Indicator x_{k-1} is slightly more important than indicator x_k
1.4	Indicator x_{k-1} is obviously more important than indicator x_k
1.6	Indicator x_{k-1} is more important than indicator x_k
1.8	Indicator x_{k-1} is extremely more important than indicator x_k

The information and data filled in by the experts can then be combined to calculate the indicator weights layer by layer using the G1 method.

If the expert gives a rational assignment of r_k , the weight w_j^g is:

$$w_j^g = (1 + \sum_{k=2}^m \prod_{i=k}^m r_i)^{-1} \quad (5)$$

$$w_{k-1} = r_k w_k (k = m, m-1, m-2, \dots, 3, 2) \quad (6)$$

Finally, the single-tier subjective weights and comprehensive weights of 1 primary indicator, 4 secondary indicators, 10 tertiary indicators and 25 quaternary indicators were completed after collating the assignment results, as shown in Table 9.

2) Determination of the weights of the measurement indicators by the entropy method

During the first phase, 309 survey questionnaires with 25 survey question items were publicly returned. Then, the importance of the 25 question items were calculated in strict accordance with the steps of the entropy value method for assigning weights, and the objective weights of the political cost measurements of environmental issues (four levels of indicators) were derived. Since the objective weighting of the political cost measurement index for environmental issues used the questionnaire survey data, there was no need for dimensionless processing of the data, and the calculation formula is as follows.

Index information entropy:

$$e_j = -k \sum_{i=1}^n Y_{ij}' \ln Y_{ij}', j = 1, 2, 3, \dots, m \quad (7)$$

Index redundancy:

$$d_j = 1 - e_j, j = 1, 2, 3, \dots, m \quad (8)$$

Index entropy:

$$w_j^s = d_j / \sum_{j=1}^m d_j, j = 1, 2, 3, \dots, m \quad (9)$$

where: e_j is the information entropy $Y_{ij}' = Y_{ij} / \sum_{i=1}^n Y_{ij}$ of index j ; d_j is the redundancy of index j ; w_j^s is the entropy weight of index j ; m is the number of indicators, n is the number of questionnaires, and k is the adjustment coefficient ($k = 1 / \ln n$).

The calculation results are shown in Table 9.

3) Portfolio weights

The key problem of combined weighting is how to determine the weight distributions of the two methods. An extensive literature review found that most researchers had used the method of subjective and objective average weighting with the minimum sum of squared deviations as the objective function to calculate the combined weight. Furthermore, this study calculated the political cost on the basis of the identified indicator system, without the need for indicator rejection and without the need to reflect the differences between expert knowledge and experience, and the objective data. The results suggested that the multiplicative synthetic normalization method with the linear weighted combination method was suitable for calculating the combined weighting.

Suppose w_j^z is the j -th index weight obtained by a linear combination of the two weighting methods, that is:

$$w_j^z = \lambda w_j^g + (1 - \lambda) w_j^s \quad (10)$$

where λ is the proportion of the index weight determined by the G1 method in the combined weight. The objective function is constructed by minimizing the deviation between the index weight determined by the G1 method and the combined weight, and the square sum of the deviation between the index weight determined by entropy method and the combined weight is:

$$\min z = \sum_{j=1}^n [(w_j^z - w_j^g)^2 + (w_j^z - w_j^s)^2] \quad (11)$$

From Formula (10), we get:

$$\min z = \sum_{j=1}^n [\lambda w_j^g + (1 - \lambda) w_j^s - w_j^g]^2 + [\lambda w_j^g + (1 - \lambda) w_j^s - w_j^s]^2 \quad (12)$$

Then, find the derivative of Formula (12) with respect to λ and set the first-order derivative to 0 to obtain $\lambda = 0.5$. Substituting $\lambda = 0.5$ into Formula (10) allows, the weight value after the combined weighting to be can be obtained as follows:

$$w_j^z = 0.5 w_j^g + 0.5 w_j^s \quad (13)$$

The subjective and objective weights of the indicators for measuring the political cost of environmental issues are unified by combining the objective weights obtained by the entropy method with the subjective comprehensive weights for each indicator obtained by the G1 method according to the above formula. These weights can then be used to calculate the combined weight of each indicator. The calculation results are shown in Table 9.

Table 9

Combined weights of the indicators for measuring the political cost of environmental issues in the first phase of the questionnaire process

Primary Indicator	Secondary Indicator Single-tier weighting	Tertiary indicators Single-tier weighting	Quaternary indicators Single-tier weighting	Composite Subjective weighting w_j^s	Questionnaire Objective weighting w_j^s	Portfolio Weighting w_j^z
(A)1	(B ₁)0.2362	(C ₁)0.4167	(D ₁)0.4248	0.0418	0.0409	0.0414
			(D ₂)0.3539	0.0348	0.0400	0.0374
			(D ₃)0.2213	0.0218	0.0382	0.0300
			(D ₄)0.2049	0.0282	0.0351	0.0317
			(D ₅)0.3443	0.0474	0.0350	0.0412
		(C ₂)0.5833	(D ₆)0.2459	0.0339	0.0417	0.0378
			(D ₇)0.2049	0.0282	0.0359	0.0321
			(D ₈)0.3846	0.0252	0.0408	0.0330
			(D ₉)0.6154	0.0404	0.0382	0.0393
			(D ₁₀)0.2212	0.0232	0.0396	0.0314
	(B ₂)0.2362	(C ₄)0.4444	(D ₁₁)0.4248	0.0446	0.0376	0.0411
			(D ₁₂)0.3540	0.0372	0.0387	0.0379
			(D ₁₃)0.5000	0.0328	0.0395	0.0362
			(D ₁₄)0.5000	0.0328	0.0416	0.0372
			(D ₁₅)0.4167	0.0248	0.0448	0.0348
	(B ₃)0.1969	(C ₆)0.3017	(D ₁₆)0.5833	0.0347	0.0403	0.0375
			(D ₁₇)0.6429	0.0273	0.0407	0.0340
			(D ₁₈)0.3571	0.0152	0.0383	0.0267
			(D ₁₉)0.6154	0.0585	0.0387	0.0486
			(D ₂₀)0.3846	0.0366	0.0368	0.0367
	(B ₄)0.3307	(C ₈)0.4828	(D ₂₁)0.5455	0.0752	0.0391	0.0571
			(D ₂₂)0.4545	0.0626	0.0366	0.0496
			(D ₂₃)0.2033	0.0392	0.0416	0.0404
			(D ₂₄)0.2846	0.0549	0.0494	0.0521
			(D ₂₅)0.5121	0.0988	0.0508	0.0748

Note: The calculation results are retained to four decimal places.

The overall weight rankings of the indicators for the political cost measurement of environmental issues in Table 9 show that although the G1 method and entropy method had different emphases in the calculation and analysis of indicator weights, there was still a high degree of consistency in the subjective ranking, objective ranking, and overall ranking results for more than half of the indicators. This result also indicates, to a certain extent, that the combined weighting method based on the G1 method and entropy method was scientific and applicable.

4.3.2. Fuzzy integrated measurement

Step 1. After calculating the combined weights of the political cost indicators for environmental issues, the final measurement analysis was carried out according to the above fuzzy comprehensive evaluation method. The data were chosen from the questionnaire data for the area surrounding the studied case in the first phase of the questionnaire process.

Establish the set of evaluation factors U;

Political cost of environmental issues: $U = \{U_1, U_2, U_3, U_4\}$;

Institutional political cost of environmental issues: $U_1 = \{U_{11}, U_{12}\}$;

Organizational political cost of environmental issues: $U_2 = \{U_{21}, U_{22}, U_{23}\}$;

Socially perceived political cost of environmental issues: $U_3 = \{U_{31}, U_{32}, U_{33}\}$;

Mass behavioral political cost of environmental issues: $U_4 = \{U_{41}, U_{42}\}$;

Validity of institutional tools: $U_{11} = \{U_{111}, U_{112}, U_{113}\}$;

Validity of system implementation: $U_{12} = \{U_{121}, U_{122}, U_{123}, U_{124}\}$;

Degree of authority and synergy of government departments: $U_{21} = \{U_{211}, U_{212}\}$;

Competence level of public officials: $U_{22} = \{U_{221}, U_{222}, U_{223}\}$;

Level of integrity of public officials: $U_{23} = \{U_{231}, U_{232}\}$;

Perceived social equity: $U_{31} = \{U_{311}, U_{312}\}$;

Effectiveness of public opinion regulation: $U32 = \{U321, U322\}$;

Social risk perception: $U33 = \{U331, U332\}$;

Implicit political behavior of the masses: $U41 = \{U411, U412\}$;

Explicit political behavior of the masses: $U42 = \{U421, U422, U423\}$.

Step 2. The set of comments (V) were determined where $V = \{\text{strongly agree, agree, relatively agree, average, relatively disagree, disagree, strongly disagree}\} = \{7, 6, 5, 4, 3, 2, 1\}$ respectively.

Step 3. The factor weights and sub-factor weights were then determined. Here the weight values (values were calculated to three decimal places) after the combination assignment in the previous subsection were used.

$A = (0.285, 0.256, 0.218, 0.274)$;

$A1 = (0.109, 0.143)$;

$A2 = (0.072, 0.110, 0.073)$;

$A3 = (0.072, 0.061, 0.085)$;

$A4 = (0.107, 0.167)$;

$A11 = (0.041, 0.037, 0.030)$;

$A12 = (0.032, 0.041, 0.038, 0.032)$;

$A21 = (0.033, 0.039)$;

$A22 = (0.031, 0.041, 0.038)$;

$A23 = (0.036, 0.037)$;

$A31 = (0.035, 0.037)$;

$A32 = (0.034, 0.027)$;

$A33 = (0.049, 0.037)$;

$A41 = (0.057, 0.050)$;

$A42 = (0.040, 0.052, 0.075)$

Step 4. The fuzzy comprehensive evaluation matrix calculation for the sub-factor set was performed, where:

$$R_{11} = \begin{bmatrix} R_{111} \\ R_{112} \\ R_{113} \end{bmatrix} = \begin{bmatrix} r_{1111} & \cdots & r_{1117} \\ r_{1121} & \cdots & r_{1127} \\ r_{1131} & \cdots & r_{1137} \end{bmatrix}$$

.....

$$R_{42} = \begin{bmatrix} R_{421} \\ R_{422} \\ R_{423} \end{bmatrix} = \begin{bmatrix} r_{4211} & \cdots & r_{4217} \\ r_{4221} & \cdots & r_{4227} \\ r_{4231} & \cdots & r_{4237} \end{bmatrix}$$

(14)

$$B_{11} = A_{11} \bullet R_{11}$$

.....

$$B_{42} = A_{42} \bullet R_{42}$$

(15)

$$B = B_{11} + \dots + B_{42}$$

(16)

Step 5. The fuzzy comprehensive evaluation result vector was synthesized. The fuzzy comprehensive evaluation result vector was obtained after inputting the measurement results for all the political cost indicators of environmental issues into the judgment matrix as follows:

$$B = B_{11} + \dots + B_{42} = (0.050, 0.126, 0.204, 0.296, 0.156, 0.123, 0.044) \quad (17)$$

According to the principle of maximum affiliation, the evaluation set for the political cost of environmental issues indicators was considered to be “average”, and the feature vector was 0.296.

Step 6. A comprehensive measurement analysis of the result vector for the fuzzy comprehensive evaluation was undertaken. The comprehensive score for the political cost measurements of environmental problems was obtained from $\theta = B \times D^T = 4.071$. That is, in the protest against the power generation project at the R steel plant in T City, the measured value for the political cost of environmental problems produced by the first stage of the protest process was 4.071.

Given the different attributes and magnitudes of the political costs in the two protest stages, the objective questionnaires used to measure the two stages were different. Furthermore, the resulting objective factor weights and fuzzy evaluation composite values were also different. Although the assignment of experts allows for comprehensive judgment and subjectivity, and the same weight is

given to both stages, the combination of the objective questionnaire data conducted simultaneously with the two protest stages still resulted in a more reasonable and accurate calculation of the political cost indicator weights for each stage. The above calculation process gives a value of 3.133 for the political cost of environmental issues during the second stage in the protest at the R steel plant power generation project in T city. In the survey, the scoring items in the seven-point Likert scale were used and were scored based on the respondents' agreement with the question items in descending order. When the political cost measurement was less than 4, then the political cost is viciously consumed and the local environmental governance system has entered a dangerous period. The government needs to focus on the political cost. However, when the political cost measurement is greater than 4, the political cost and political benefit to the environmental governance system are in a balanced state, and the local environmental governance system is in a safe and stable period.

5. Conclusions and policy implications

5.1. Main conclusions

After measuring the combined weights of the political cost of environmental issues, it can be concluded that the weights of the measured indicators evolved according to the different temporal and spatial states of the measured objects and environmental mass events, and the importance of each indicator in each stage to the political cost of environmental issues varied. Among them, mass behavioral political costs and the five categories that included fourth-level indicators had the greatest weight among all the indicators and had a greater impact on the political cost results. They are also the core elements affecting political cost consumption. And three other political costs (institutional, organizational, and social perception) that have a more balanced degree of influence. In the four-level indicator system, the weight of “negative behavior of the public during the stage” is the largest among the stages of the protest process, and “public satisfaction” is the second largest factor affecting the political cost, so the government must focus on the analysis of environmental problems; The other four levels of indicators significantly fluctuated in their weights at each stage depending on the nature of the event. In addition, when the reliability and validity of the questionnaire were tested, it was found that the scores for respondent evaluation of institutional and organizational political costs caused by environmental problems to environmental governance were more consistent, and the values of these two indicators in the questionnaire were high in the reliability and validity tests. The variability of the respondent evaluation scores on the social perception political cost of environmental problems and the behavioral political cost of the masses indicators were greater than for the other indicators, which makes the values of these two indicators in the questionnaire low in the reliability and validity tests. These two situations are consistent with the assumptions of the pre-survey and the actual situation highlighted by the field research.

The political costs of the protest against the R steel plant in T city were already evident during the first stage of the protest event. However, because the local government did not pay much attention to it due to reasons such as “increase in residents' income” and “increase in local GDP”, the political cost of environmental issues evolved during the first protest stage. In the first stage, local governments failed to provide timely guidance, treatment, and systems to address the problems and public opinion information reflected by the public. At the same time, the political cost of environmental problems in the first stage was 4.071, which meant that the political cost significantly increased during this stage and was at the critical point of the “cost-benefit” equilibrium for the government to manage environmental problems. In this context, if the local government does not pay attention to the problem, it will inevitably evolve into the second protest stage. The second stage witnessed negative public behavior, and negative public political psychology began to expand and spread rapidly. However, the failure of local government to carry out effective public emergency responses and governance led to the continuous expansion of the political cost consumption for environmental issues. At this point, the measured value for the political cost of environmental problems was 3.133, suggesting that the X town government should introduce and adopt timely governance policies and invest more active governance efforts to control the continued rise in political cost depletion. This index system shows that the measurement results have high consistency with the actual event evolution results, and it also proves that the measurement index system and measurement method for ascertaining the political cost of environmental issues constructed in this study are practical. Therefore, when practicing local environmental governance, the government can use the index system and measurement method to measure the size of the political cost of environmental issues in the region and use it as an important basis for measuring the performance of environmental governance.

5.2. Policy implications

Establish political cost awareness and adopt appropriate assessment and enforcement efforts. Local governments should establish a political cost control mechanism and an automatic identification and monitoring mechanism, make good use of the emotional buffer in the virtual space of the network, and pay attention to early warnings during each stage of environmental governance in order to issue and adopt governance policies in a timely manner to control the consumption of political costs. At the same time, local governments often form their own preferences based on local economic benefits, taxation, and governance costs to determine the intensity of environmental governance policies. When economic benefits are consistent with local environmental governance preferences, local governments are prompted to implement governance policies while ignoring political costs. When the two preferences are inconsistent, local governments often adopt incomplete implementation and avoidance of responsibility for environmental governance. However, the political resources held by political active subjects when managing the environment are limited. Therefore, this approach will increase the consumption of political costs, will have an impact on social stability, the business environment, and later policy implementation, and will also hinder local economic development. Therefore, it is important that public officials improve their professionalism. They should be equipped with professional instruments and technical facilities to improve the collection and analysis of environmental governance monitoring, to enable them to make rapid responses and decisions to some problems in environmental governance, and to pre-design, accurately predict, and "advance" governance. It is also necessary to appropriately control the administrative accountability of officials, gradually increase public reputation evaluation, carefully evaluate whether the policy objectives and political costs match, and reasonably divide the boundary between social supervision and government supervision to prevent policy overflow and policy overrun.

Internalize the externalities of environmental governance and reduce the cost of public participation. Public behavior is a core element that affects the consumption of political costs. This is not only a warning to remind some public officials who follow the risky behavior of concealing information asymmetry, but will also give the heads of government reassurance. When it comes to environmental governance issues, officials should "let go" so that the governance of environmental issues can be more effectively implemented. At the same time, further promoting government efforts to strengthen its active governance strategy may have a negative impact on local economic development (decreased corporate operating income and lower taxation), but it is possible to seek appropriate feedback paths for this, such as using an environmental protection tax to pay for pollution supervision and governance, transfer payment funds could be used to reward companies that actively reduce emissions by improving pollution reduction equipment, reduce their overall tax burden, build a complete environmental monitoring system and monitoring information system, or provide corporate subsidies for technical innovation improvement total factor productivity-economic growth-drives local governments to increase investment in environmental governance and is a benign interactive cycle chain. In addition, the rational perception of the public towards environmental governance should be improved through various channels and platforms, such as official media and social organizations, and the public's psychological intervention mechanism should be improved. It is also possible to carry out cross-departmental and cross-organization collaborative governance, determine the subsidy intensity based on the public perception of environmental governance, efficiently handle public letters, visits, complaints and other communication, rationally design participation forms, broaden public participation channels, and reduce public participation costs.

5.3. Limitation and future direction

The increasing demands to construct an indicator system and the associated scientific and rigorous selection of indicators mean that it is necessary to consider both micro and macro effects when constructing the indicator system, and to pay attention to both current and long-term interests, i.e., to be comprehensive and focused. Therefore, this study adopted a scientific, statistical method that combined qualitative and quantitative analyses to construct an indicator system for the political cost of environmental issues that passed the relevant tests. It also underwent improvements, resulting in a more reasonable structure for the indicator system, a more appropriate number of indicators, and good reliability and validity. This method is a stable and effective measurement framework, which lays a foundation for future research and fills part of the research gap in the political cost of environmental issues. It is hoped that this study will help local governments identify the main factors affecting the changes in the political cost of environmental issues so that they can propose governance solutions and strategies from a multidimensional perspective, precisely control the political cost of environmental issues, and better improve the quality and efficiency of environmental governance. The study of the political costs of environmental issues is inevitably a long-term and complex systematic subject. Since there are relatively few related studies in China, and the theory and research system are not perfect, this

study had some shortcomings. For example, the concept and index system for the political cost of environmental issues may need to be further expanded, and the measurement method should be improved and upgraded, both of which will be addressed in future studies. At the same time, this study will serve as a beginning and contribute to the study of political costs of environmental issues.

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Authors' Contributions

All authors contributed equally to this work. Specifically, X. L. developed the original idea for the study and designed the methodology. T. C. completed in the survey and drafted the manuscript, which was revised by Z. Z. and L. L. All authors read and approved the final manuscript.

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