Original Research

The Impact of Environmental Information Disclosure on Water Quality

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Abstract

The strain of environmental deterioration is growing in tandem with the rapid growth of the economy. This research examines the impact of regional environmental information disclosure on water quality in China. The results show that the higher the degree of information disclosure is, the more neutral the water environment. Based on the baseline regression, the study analyses the mediation effect and moderating effect. The results show that urbanization rate plays a part role in mediation effect. Also, Natural population growth rate and sewage treatment rate have a moderating effect. After a series of robustness tests, this conclusion was still confirmed. This paper makes policy recommendations and suggests research directions for the future.

Keywords: environmental information disclosure, water quality, environmental regulation, urbanization rate

Introduction

As a bottom-up tool of environmental regulation, environmental information disclosure has become the focus of academic research and practice all over the world. So far, more than 20 countries around the world have established pollutant release registration schemes, such as TRI in the United States. Many countries have adopted environmental disclosure tools to improve the quality of their environment. India's green rating program and Indonesia's performance evaluation and rating program, for example, have spurred emissions reductions. However, other studies have shown that environmental disclosure has limited or no impact on pollution reduction. Environmental issues are an important research topic in China. Since the Reform and Opening Up, the Chinese government has implemented environmental regulatory measures to achieve win-win economic development and sustainable environmental development [1]. These initiatives have achieved remarkable outcomes. Environmental information disclosure is frequently used to supply traditional environmental regulations [2, 3]. The Regulations on Government Information Disclosure and Measures on Environmental Information marked the start of the investigation into environmental information disclosure. Since 2008, relevant departments have published bulletins on state and provincial environmental

conditions, bulletins on regional or river basin environmental conditions, and weekly (daily) reports on urban air conditions. China's environmental information disclosure is improving each year, and the overall index of ecological governance is rising.

In the field of resource and environmental economics, the research on water pollution is mainly carried out from the influencing factors and the negative effects of water pollution. The literature on the influencing factors of water pollution is mainly reviewed from five aspects: the characteristics of water pollution itself, the increase in acid gas emissions, coal power generation, water pollution and economic development. The literature studying the negative effects of water pollution is mainly reviewed from four aspects: non-point source pollution in agriculture, water source pollution [4], water pollution and water pollution damage [5, 6]. The relationship between environmental information disclosure and environmental governance is a hot topic for scholars, and mainly focuses on the relationship between information disclosure and air pollution [7-9]. Water pollution research mainly focuses on nonpoint source pollution in agriculture [10]. However, overall water pollution research is less than air pollution research. Given the background of frequent acid rain events in China, it is necessary to study the impact of environmental information disclosure on water quality.

This paper uses the two-way fixed effects model to study the influence of government environmental information disclosure on water quality, and analyzes the mediation effect and moderating effect. Considering the large differences in the development of separate cities in China, this paper conducts heterogeneity analysis from three aspects: urban location, urban type and rainfall. Various robustness tests show that the conclusions are robust. Given the wide disparities in the growth of Chinese cities, this research undertakes a heterogeneity analysis from three perspectives, urban location, urban-type and rainfall. After employing a range of robustness testing methods, this paper's conclusions are sound.

The following are this paper's innovations:

1. This paper studies the impact of environmental information disclosure on water environment from the perspective of public participation and ENGOs.

2. Natural population growth rate and centralized sewage treatment rate were found as moderating variables

3. This study looked at the level of urbanization as a mediating variable. The influence mechanism of environmental information disclosure on water environment is also found. The discovery of this influencing mechanism provides a basis for policy making.

The remainder of this paper is organized as follows. The second part reviews the previous research results. The third part designs the research. The fourth part shows empirical findings. The fifth part shows robustness tests. The sixth part is the research conclusion.

Literature Review and Hypothesis

The Evolution of Environmental Information Disclosure

Formal environmental regulation and informal environmental regulation are two types of environmental regulation. Environmental information disclosure belongs to relaxed environmental regulation because it is not mandatory. Since the 20th century, significant countries have gradually shifted from the command-and-control environmental regulation mode to the environmental governance mode with extensive public participation in decision-making. Developed countries implemented an environmental information disclosure system for environmental governance in the 1990s. Transparency reform increasingly appeared in the government plan, thanks to US President Barack Obama's "Open Government Partnership" introduced in 2011. In June 1998, the Fourth European Ministerial Conference on the Environment adopted the Aarhus Pattern. Following the Convention, the European Union adopted the Guidelines for the Implementation of the Aarhus Convention (2000), the Directive on Public Access to Environmental Information (2006) and other legal documents to improve the government environmental information disclosure system.

Under Ecological Civilization Construction in China, environmental information disclosure has been widely used in environmental governance. According to the classification of Huang Qinghuang et al. (2017), environmental regulation tools can be divided into command-and-control regulation tools, market-incentive regulation tools and public participation regulation tools.

Environmental information disclosure is the third category of environmental regulation tools. According to statistics, environmental pollution can be controlled when pollution control accounts for approximately 3% of their respective GDP in developed countries. In contrast, environmental pollution is not proportional to the investment in pollution control in China [11]. The Chinese government urgently needs to improve the method of environmental regulation and improve the efficiency of pollution control. China's environmental data disclosure began late and progressed slowly. Although the Chinese government has issued relevant rules and regulations, there are only a few scattered regulations on the publication of government environmental information, which cannot be considered academic research development. Two examples are Article 11 (2) of the 1989 Environmental Protection Law and Article 31 of the 2002 Clean Production Promotion Law. Environmental information disclosure has also attracted attention since the policy of

Beautiful China was proposed, and the environmental policy system has been improved. Compared with industrialized countries such as the European Union and the United States, China's environmental information disclosure is still in its early stages, and the GDP-oriented promotion mechanism has produced a significant gap between environmental oversight and law enforcement [12].

The Economic Impact of Environmental Information Disclosure

Experts are more concerned about the influence of tight environmental rules on economic growth as ecological and environmental restrictions become more severe [13]. Substantial restrictions shift a portion of production value from polluting enterprises to polluting enterprises, boosting the upgrading of regional industrial structure [14]. The traditional view is that increasing the intensity of environmental regulation will increase enterprise cost and reduce enterprise productivity. However, some academics think that, from a dynamic perspective, environmental protection and economic development are always mutually exclusive. Environmental regulating policies can lead to a win-win situation in terms of both environmental protection and economic growth. The "Porter hypothesis" asserts that environmental regulations increase the production costs of regulated businesses in the near term and diminish their relative [15]. On the other hand, environmental legislation stimulates businesses to participate in more innovative activities and boost productivity in the long run [16, 17]. An increasing number of scholars are using the "Porter hypothesis" to justify their positions in relevant studies: The intensity of environmental regulation, to some extent, promotes the improvement of R&D innovation efficiency in industrial industries [18], improves the supervision and incentive of local government environmental regulation, and allows geographically adjacent cities to reach a consensus on coordinated regulation, all of which contribute to China's long-term economic growth [19].

Water Quality Impact of Environmental Information Disclosure

The research on the relationship between information disclosure and water environmental governance can be split into three categories: positive correlation, negative correlation, and nonlinear correlation. Most scholars accepted the positive correlation. WANG Y. et al. [20] analyzed water quality rating data from 1995 to 1999 to confirm that informal river pollution regulation had a considerable positive influence on water quality in India. Some studies have discovered that environmental information sharing has a favorable impact on a region's environmental quality, with a double threshold effect [21]. Supply, environment, and demand are three policy mechanisms used to disclose information.

Personnel training and capital investment are examples of supply policy measures. Laws and regulations, as well as target planning, are environmental policy tools. Public procurement, public-private partnerships, demonstration projects, and encouragement and guidance are demand-based policy strategies. The government routinely employs laws and regulations as part of its environmental policy toolkit. The government commonly uses encouragement and advice as demand-type policy measures. The government typically employs science and technology support tools in its supply-oriented policy instruments. The current use of biological monitoring technology, kits, and the Bei Dou communication system in aquatic environment monitoring, for example, can be classified as scientific and technological support instruments. Water environment monitoring that is intelligent, accurate, and quick can meet the needs of the government, businesses, and the general public.

Information disclosure puts the government under bottom-up public opinion pressure and top-down regulatory pressure, causing it to prioritize the treatment of pollutants, which negatively influences environmental governance. The possible impact of government environmental information disclosure on water environmental governance is called the "reputation impact" in economic theory. On the one hand, the reputation effect is reflected in how certain pollutants are treated and the order in which they are treated. The government would prioritize high concern pollution of deep concern to society and the public in environmental governance, resulting in the treatment of the symptoms rather than the fundamental cause of environmental governance. On the other hand, sharing of environmental information puts external pressure on local governments to manage pollution to some extent. According to the "state-pressure-response" environmental assessment model, after obtaining specific environmental governance results, some cities may reduce the degree of environmental information sharing and the efficiency of environmental governance. Yu et al. [22] also questioned the effectiveness of China's environmental data sharing, claiming that present pollution control policies and regulations have failed to achieve the desired goal of pollution control and reduction.

The relationship between information disclosure and environmental governance will be influenced by the distinct national circumstances of each country. For example, information disclosure regulations in poor and developed countries will have distinct results. Some scholars argue that there is a nonlinear link between government transparency and ecological efficiency performance, starting with the standpoint of environmental efficiency. Because the government in China is not elected and there is less governance pressure from information disclosure, it is not as effective in controlling pollution as it is in democratic countries. According to an examination of environmental

information disclosure in China, transparency policies have no impact on improving information disclosure [23]. Traditional environmental rules, such as sewage charges and environmental penalties, are effective in China in regard to pollution control. Nevertheless, there is no evidence that environmental transparency enhances the effectiveness of traditional environmental regulations [24]. Differences in PITI between cities imply various levels of regional development. It also demonstrates that the degree to which environmental information disclosure measures are implemented varies by location. Environmental information disclosure has a different impact on environmental governance depending on how well it is implemented.

Hypothesis

The literature focuses on the correlation between information disclosure and environmental management, the factors that influence environmental information disclosure, and pollution treatment methods. The following several things should be done better.

(1) Existing research focuses primarily on information disclosure and air pollution, such as nitrogen dioxide, sulfur dioxide, and nitrogen oxide emissions [25-27]. Water pollution research in China focuses primarily on nonpoint source pollution in agriculture. However generally, water pollution research is less than that on air pollution [28-30].

(2) Most existing research focuses on the factors that influence government environmental information disclosure. Despite creating a rich index system, the impact of government environmental information disclosure on environmental governance has been overlooked. Environmental information disclosure and pollution control are adequately coupled due to a lack of exposure and the study of regional variances.

(3) Given the severity of water and other types of pollution in China, future research should also focus on the potential impact of water and different types of pollution;

(4) Relevant studies are becoming more refined in selecting indicators, ranging from pollutant discharge to water quality indicators. The problem of water quality can better reflect the results of negative externalities. Literature on non-market assessments of water quality has found that societies are willing to pay substantial sums for specific local water quality improvements [31]. Many studies on water pollution employ the NH_{32}, DO, and COD indices [32-34], however, there is relatively little research on the pH value as an index of the water environment, and it is only marginally included in studies on transboundary contamination. Considering the frequent occurrence of acid rain in China, this paper adopts the PH data of water quality automatic weekly monitoring weekly reported by the China Environmental Monitoring Station to build a panel model to study the impact of government environmental information disclosure on water environmental governance.

This study makes the following theoretical assumptions based on the above analysis:

Hypothesis 1: Public publication of environmental information has a good impact on water pollution mitigation.

Experimental

Variable Definition and Model Setting

This paper used the absolute value of (PH-7) as the explained variable and government environmental information disclosure as the explanatory variable to investigate the impact of government environmental information disclosure on the pH value of the aquatic environment. PITI data, issued jointly by the IPE and the NRDC, were used to assess the level of government transparency. Control variables included economic openness (lnFDI), population density (lnpop), education level (lnedu), economic development level (lngdp), and unemployment level (lnu). Actual foreign investment in the city is used to gauge the city's economic openness. The natural growth rate of the city is used to calculate population density. The total number of students in undergraduate and junior colleges, secondary vocational schools, and elementary and secondary schools is divided by the city's entire population at the end of the year to determine the education level. All of the above

Table 1. Variables, meanings, and descriptive statistics.

Variable name	Variable symbol	Obs	Mean	Std. Dev.	Min	Max
Water quality acid and alkali condition	NpH	264	0.702	0.393	0.002	1.863
Government information	piti	264	0.439	0.156	0.09	0.771
Degree of openness	lnFDI	251	11.217	2.045	1.099	14.941
Degree of economic openness	lnpop	231	1.540	0.823	-2.408	3.096
Density of population	lnedu	250	7.412	0.371	5.938	8.895
Education level	lngdp	262	17.281	0.941	14.910	19.451
Unemployment level	lnu	262	-0.003	0.002	-0.010	-0.0002

control variables are logarithmic, and the descriptive statistics of the variables are listed in the table below.

Panel data have been widely used in empirical research to investigate real problems in two dimensions of time and section [35]. Individual effects are only considered in the fixed-effect model, which ignores time effects. As a result, the conclusion frequently deviates significantly from reality, and the discrepancy increases as the time impact increases. This study considers the individual impact and the time effect, which are based on the preceding principles. Meanwhile, the findings of the Hausman test reveal that the null hypothesis should be rejected and the fixed effect model should be utilized instead of the random effect model. This research constructed the following model to rigorously investigate the impact of local-level urban environmental information sharing on NpH:

$$\text{NpH}_{it} = \beta_0 + \beta_1 piti_{it} + \beta_2 Z_{it} + \sigma_t + \mu_i + \varepsilon_{it} \quad (1)$$

In Equation (1), i denotes distinct regions (prefecture-level cities) and t denotes different times. NpH is the explained variable, reflecting the absolute value of (ph-7); PITI is the government's environmental information disclosure. Z_{it} denotes control variables, including the degree of economic openness (lnFDI), population density (lnpop), level of education (lnedu), economic development (lngdp), unemployment (lnu), and interaction terms for explanatory variables and population density (plnpop). σ_t denotes the time effect of not changing with the individual, μ_i denotes individual effects of not varying over time, and ε_{it} denotes a random error term.

Literature on the relationship between urbanization rate and resources and environment shows that urbanization rate and resources and environment of cities first deteriorate and then improve [36]. In other words, the higher the urbanization rate, the greater the pressure on resources and environmental deterioration. When the urbanization rate reaches a certain level, resource and environment deterioration presents a trend of improvement [36]. Based on this, the urbanization rate was selected as a mediator variable to analyze the mechanism of environmental information disclosure on water quality. China's population is too large, and the rapid growth of population growth leads to the overuse of resources and difficulties in environmental protection [37]. Some scholars have studied the relationship between sewage treatment rate at sewage outlets and the seawater environment. The higher the sewage treatment rate at sewage outlets and the seawater environment [38]. Based on this, natural population growth rate and sewage treatment rates were used as moderating variables. The degree of urbanization is used as an intermediary variable in this paper to investigate the mechanism of government environmental information disclosure on water environmental governance, using Formulas (2), (3), and (4) as the intermediary impact model.

$$NpH_{it} = \beta_0 + \beta_1 piti_{it} + \beta_2 Z_{it} + \sigma_t + \mu_t + \varepsilon_{it} \quad (2)$$

$$lnUR_{it} = \propto_0 + \propto_1 piti_{it} + \propto_2 Z_{it} + \sigma_t + \mu_t + h_{it} \quad (3)$$

$$NpH_{it} = d_0 + d_1 piti_{it} + d_2 lnUR_{it} + d_3 Z_{it} + \sigma_t + \mu_t + k_{it} \quad (4)$$

This article selects two moderating variables, the sewage concentration rate and PITI by item and the natural population growth rate and PITI by entity. Equations (5) and (6) are the regulatory effect models established in this paper.

$$NpH_{it} = b_0 + b_1 piti_{it} + b_2 plnPD + b_3 Z_{it} + \sigma_t + \mu_t + \varepsilon_{it} \quad (5)$$

$$NpH_{it} = c_0 + c_1 piti_{it} + c_2 plnpop + b_3 Z_{it} + \sigma_t + \mu_t + \varepsilon_{it} \quad (6)$$

Sample Selection and Data Source

IPE and NRDC produced the first PITI report in 2008, the first year where information disclosure occurred in China. Because the first PITI release may not cover many cities or collect detailed data, the research data began in 2010. In 2017, regulatory information on pollution sources was made public for the first time. Several major cities have made daily supervision information available to the public regularly. Public data have exploded, and the federal government has undertaken unprecedented environmental oversight. With the development of environmental nongovernmental organizations, environmental information disclosure by local governments in China has advanced quickly [39, 40]. This paper used China's prefecture-level cities as the research object from 2010 to 2017 to assure the research's continuity and integrity. The following is the data processing procedure. Removing Xinjiang and Tibet in view of data integrity and availability concerns. The PITI data were decreased by 100 times before full-sample reference regression. Expanding the estimated coefficient and standard error correlations 100 times to make the coefficient changes more intuitive. Water quality data were manually collected and compared from the weekly water quality monitoring report. Finally, the data of 39 prefecture-level cities in China from 2010 to 2017 were obtained. The data mainly come from The Chinese Urban Statistical Yearbook, PITI report jointly released by IPE and NRDC, and water Quality Inspection Weekly report. It should be pointed out that the water quality data in this paper come from China's water quality testing station, just like this article [41]. Since water quality monitoring stations in China are densely distributed at river outfalls, complete data of 39 prefecture-level cities were obtained after matching PITI data.

Regulatory information, self-monitoring, interactive impacts, emission statistics, and EIA information are part of PITI's evaluation criteria. Automatic

national defense monitoring and important pollutant discharge units are two types of self-monitoring. The environmental inspector and open application are two types of interactive responses. Enterprise emission data are referred to as emission data. Relevant EIA data are referred to as Eia data. Industrial wastewater, urban home sewage, and agricultural nonpoint source sewage are the primary sources of water pollution in China. Industrial sewage is the largest cause of water pollution in China. Because China's industrial water pollution in water pollution control is important, this article will be a heterogeneity analysis according to the degree of industrialization. There is currently no universal standard for defining a heavy industry city. Chen Qi and other experts have categorized 22 cities, including Beijing, as rich industrial cities, while others have been classified as non-heavy industrial cities. Shijiazhuang, Baotou, Lianyungang, and Guilin are finally defined as heavy industrial cities based on data availability, whereas other cities are designated as nonheavy industrial cities.

Results and Discussion

Baseline Regression

The regression results are shown in the table above. Time and individual fixed effects are used to estimate the first column. Based on the first column, a time city interaction fixed effect is introduced in the second column for estimation. The bootstrap standard error is used to estimate the third column. When controlling for time and individual fixed effects, the regression coefficient of PITI on NpH was -0.715. NpH reduces by 0.715 units on average for every 100 units of PITI increase, passing the 1% significance test. These findings show that PITI significantly influences NpH, independent of whether the time or individual fixation effect is controlled. This demonstrates that the outcomes are mainly reliable. The greater the level of environmental information disclosure in a given location is, the closer that area's water quality is to neutral, and the lower the risk of overacidity and overalkalinity. It should be noted

Table 2. Baseline estimation results.

	(1)	(2)	(3)	(4)
VARIABLES	NpH	NpH	NpH	NpH
piti2	-0.715***	-0.591**	-0.469***	-21.74***
	(0.243)	(0.292)	(0.181)	(7.222)
lnFDI	0.00934	0.0157	-0.0607***	0.0384
	(0.0161)	(0.0141)	(0.0144)	(0.0773)
lnpop	-0.0932*	-0.114*	-0.0602**	-3.538***
	(0.0538)	(0.0581)	(0.0250)	(1.284)
lnedu	-0.135**	-0.131**	-0.100*	-0.414
	(0.0581)	(0.0612)	(0.0530)	(0.318)
lngdp	-0.265*	-0.188	0.0944**	0.500*
	(0.142)	(0.159)	(0.0473)	(0.266)
lnu	-27.43*	-16.06	-27.67***	-181.9***
	(14.21)	(17.17)	(7.533)	(67.82)
plnpop	0.262**	0.252**		8.663***
	(0.120)	(0.125)		(3.154)
Constant	6.373**		0.707**	3.338
	(2.449)		(0.276)	(3.591)
Observations	207	205	207	206
R-squared	0.171		0.104	-12.403
Number of administrative division code	39	39	39	39
Time fixed effect	YES	YES	YES	NO
Individual fixation effect	YES	YES	YES	NO
Time-city fixed effect	NO	YES	NO	NO

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

that due to data availability, the results of this paper are affected to some extent by sample representativeness.

Robustness Test

There may be omissions of variables in this study. The robustness test was conducted by gradually increasing the control variables, as stated above. PITI exhibited significant negative impacts on NpH as the control variable steadily increased, demonstrating that the conclusion is still valid.

Beijing, Shanghai and other municipalities may affect the results of baseline regression. This paper removed Beijing, Shanghai, Tianjin, Chongqing and four other municipalities from the total sample before regression. The elimination of the above four cities can eliminate the influence of extreme values and make the regression result closer to the average situation in reality. The results in the first column show that the COEFFICIENT of PITI is still significantly negative; that is, the elimination of municipalities does not affect the conclusion of this paper.

The choice of explained variables may affect the results of regression. This paper replaced the absolute value of the explanatory variable (PH-7) with the square of (ph-7), and then regression was performed. The regression coefficient of PITI is still strongly negative, as seen in the second column, indicating that the conclusion of this research is sound.

In order to reduce the influence of endogeneity problem, this paper adopts two-stage regression. In this paper, air pressure is selected as a instrumental variable. According to the existing literature, air pressure may be a good tool variable. This variable is not related to the random error term and is related to the core explanatory variables. Table 5 shows the specific regression results. The results show that the coefficient of instrumental variables is significant at the level of 1%, which is consistent with the correlation between instrumental variables and environmental information disclosure. Kleibergen-paap RK Wald F value was 7.967. However, the traditional weak instrumental variable test may have large deviation when there are heteroscedasticity, autocorrelation and clustering [43]. However, these problems exist in this study. As in the previous results,

Table 3. Robustness test 1.

VARIABLES	(1) NpH	(2) NpH	(3) NpH	(4) NpH	(5) NpH
piti	-0.318**	-0.341**	-0.337**	-0.304*	-0.715***
	(0.155)	(0.160)	(0.160)	(0.156)	(0.243)
lnFDI	0.00882	0.00563	0.00437	0.0135	0.00934
	(0.0159)	(0.0166)	(0.0165)	(0.0162)	(0.0161)
lnpop	0.00201	0.0174	0.00998	0.0115	-0.0932*
	(0.0227)	(0.0255)	(0.0255)	(0.0247)	(0.0538)
lnedu		-0.0634	-0.0713	-0.115**	-0.135**
		(0.0549)	(0.0586)	(0.0581)	(0.0581)
lngdp			-0.169	-0.247*	-0.265*
			(0.145)	(0.144)	(0.142)
lnu				-29.09**	-27.43*
				(14.36)	(14.21)
plnpop					0.262**
					(0.120)
Constant	0.776***	1.265***	4.211*	5.695**	6.373**
	(0.182)	(0.481)	(2.479)	(2.459)	(2.449)
Observations	221	211	209	207	207
R-squared	0.079	0.090	0.109	0.146	0.171
Number of administrative division code	39	39	39	39	39
Time fixed effect	YES	YES	YES	YES	YES
Individual fixation effect	YES	YES	YES	YES	YES

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

Table 4. Robustness test 2.

	(1)	(2)
VARIABLES	NpH	NpH2
piti	-0.673**	-1.176***
	(0.266)	(0.404)
Constant	6.489**	9.547**
	(2.543)	(4.064)
Observations	190	207
R-squared	0.161	0.166
Number of administrative division code	36	39
Time fixed effect	YES	YES
Individual fixation effect	YES	YES
Control variables	YES	YES

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

this paper must use robust standard error. For the possible weak instrumental variable, this paper uses the twostepweakiv program of stata17 software to test [44], and the results show that the tool variables are relatively effective.

Analysis of Heterogeneity

Separate regions have distinct levels of environmental information disclosure, environmental pollution levels and economic development levels. To investigate the different impacts of PITI on NpH in different regions, 39 cities in the sample were divided into eastern (11), central (10), and western (8) cities by geographical location. The regression results are shown in the table above. PITI has a significant negative effect on NpH in both eastern and western cities, and the regression coefficient of PITI in western cities is more significant than that in the east of cities. PITI in central cities had a positive effect on NpH, and did not pass the significance test. The above results indicate

Table 5. Regression results of instrumental variables.

VARIABLES	(1)	(2)
qy	0.205*** (0.073)	-21.738*** (7.222)
Time fixed effect	YES	YES
Individual fixation effect	YES	YES
Control variables	YES	YES
F-value	7.97	7.967

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

that the PM2.5 concentration and industrial wastewater discharge in eastern cities far exceed those in the central and western part, and they face greater environmental pressure. Although the level of environmental information disclosure in the eastern region is higher than that in the western region, the positive impact of PITI on the aquatic environment is smaller than that in the western region. The ecological environment of the western region is better than that of the eastern region, and information disclosure has a greater positive impact in the western region. In contrast, the disclosure of environmental information negatively impacts the central part. Due to the transfer of high-polluting and energy-consuming industries from the east and the widespread use of coal for heating, the central region has faced increasingly severe pressure and the pressure of controlling various pollutants in recent years. According to the multitask principal-agent theory, local governments prioritize the treatment of pollutants with high public concern (such as haze). However, the central region has faced severe haze in recent years, which has been slightly improved in recent years. The pH value of a balanced water environment is of less concern, thus showing a positive impact of PITI on NpH.

In the above analysis, Shijiazhuang, Baotou, Lianyungang, and Guilin are classified as heavy industrial cities, whereas other cities are categorized as nonheavy industrial cities. The empirical results are presented in the following table. The first column shows how PITI affects NpH in heavy industry cities, whereas the second column shows how PITI affects NpH in nonheavy industry cities. In both heavy and nonheavy industry cities, PITI has a strong detrimental impact on NpH. However, there are differences in the significance and coefficient between heavy industry and nonheavy industry cities, indicating that better environmental information disclosure can lessen the over-acid or over-alkali water environment phenomenon. The beneficial effect of environmental information disclosure in heavy industry cities is much greater than that in nonheavy industry cities.

The majority of river water originates from rainfall, which significantly impacts river water quality. More sewage discharge and less inflow were the main causes of water contamination [45]. Because the Qinling and Huaihe River lines are equal precipitation lines of 800 mm and the dividing line between humid and subhumid areas, sample cities are divided into subhumid areas (11 cities) and humid areas (28 cities) according to the Qinling Huaihe River lines. The following are the regression results. The impact of PITI on NpH in subhumid locations is the first, while the effect of PITI on NpH in humid places is the second. Environmental information sharing has a negative but minor effect on NpH in the subhumid zone. Environmental information disclosure has a considerable favorable impact on NpH in humid environments. The effect of environmental information disclosure on NpH differs from rainfall in general.

Table 6. Analysis of heterogeneity.

	Urban location heterogeneity			City-type heterogeneity		Rainfall heterogeneity	
	Eastern	Central	Western	Heavy industry city	Non-heavy industry Industry city	Half moist area	Moist area
VARIABLES	NpH	NpH	NpH	NpH	NpH	NpH	NpH
piti	-0.917**	0.231	-2.697**	-10.46*	-0.699***	-0.257	-0.538**
	(0.350)	(0.339)	(1.186)	(1.086)	(0.242)	(0.678)	(0.267)
Observations	83	75	49	16	191	41	166
R-squared	0.291	0.284	0.397	0.998	0.201	0.689	0.199
Number of administrative division code	14	15	10	3	36	11	28
Time fixed effect	YES	YES	YES	YES	YES	YES	YES
Individual fixation effect	YES	YES	YES	YES	YES	YES	YES
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Mechanism Analysis

Moderating Effect

The regression findings of the moderating effects are shown in Table 6. The interaction term between PITI and the centralized treatment rate of sewage treatment facilities (PITI * lnPD) is added to the first column. The interaction term between PITI and the natural population growth rate (PITI * lnpop) is added to the second column. The results demonstrate that at a level of 5%, the coefficient of plnPD is positive and significant. This is in contrast to PITI's effect on NpH, which suggests that the greater the centralized treatment rate of sewage treatment plants is, the weaker the positive impact of environmental information disclosure on NpH. The favorable effect of environmental information disclosure on NpH can be amplified when the centralized treatment rate of sewage treatment plants is lower.

The coefficient of plnPOP is positive and significant at the 5% level. The coefficient of the interaction term plnPOP indicates that when the natural population growth rate increases, the positive effect of environmental information disclosure on NpH decreases. In contrast, when the natural population growth rate is lower, the positive effect of environmental information disclosure on NpH can be enhanced. China's large
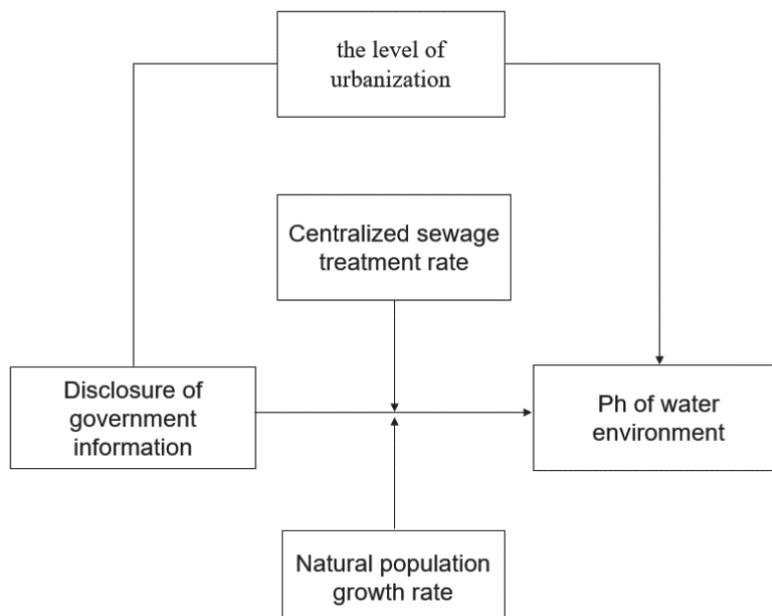
Fig. 1. Depicts the regulatory role of the regulatory variables.

Table 7. Regulatory effect results.

	(1)	(2)
VARIABLES	NpH	NpH
piti	-6.697**	-0.715***
	(3.003)	(0.243)
lnPD	-0.390**	
	(0.196)	
plnPD	0.0143**	
	(0.00673)	
lnpop	0.00476	-0.0932*
	(0.0247)	(0.0538)
plnpop		0.262**
		(0.120)
Constant	6.280**	6.373**
	(2.750)	(2.449)
Observations	202	207
R-squared	0.158	0.171
Number of administrative division code	39	39
Time fixed effect	YES	YES
Individual fixation effect	YES	YES

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

Table 8. Results of the mediation effect test.

	(1)	(2)
	NpH	NpH
lnUR	-0.262***	
	(0.063)	
piti	-0.306	
	(0.361)	
Controlled variables	YES	
Sobel Z	-2.295**	
Sobel Z-p value	(0.022)	
Goodman-1 Z	-2.25**	
Goodman-1 Z-p value	(0.024)	
Goodman-2 Z	-2.343**	
Goodman-2 Z-p value	(0.019)	
bs1(P)		(-0.578,-0.053)
bs1(BC)		(-0.573,-0.042)
bs2(P)		(-1.200,0.464)
bs2(BC)		(-1.264,0.419)
Urban fixed effect	NO	NO
Individual fixation effect	NO	NO
The proportion of intermediary effect	48.47%	

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

population base and high natural population growth rate will lead to a series of problems such as environmental pollution, ecological destruction and energy shortage. The difficulty of governance further increases with the deterioration of the environment. When environmental degradation reaches a certain point, it will weaken the positive impact of environmental information disclosure or other environmental regulation tools on water environmental governance.

Mediation Effect

A previous study showed that environmental information disclosure positively impacts the pH of the water environment. Based on theoretical analysis, this section tests the internal mechanism of environmental information disclosure to maintain water quality neutrality. Some scholars have pointed out that land-use change can affect regional hydrological ecosystem service function by changing surface physical characteristics and water cycle process [42]. Based on this, the land area of administrative built-up area, namely urbanization level, is selected as an intermediary variable in this section. Table 7 reports the results of the mediation effect model. The first list is the Sobel test results, and the second list is the bootstrap test results.

The Sobel-Z value was negative at the significance level of 5%, indicating the existence of a mediating effect, which accounted for 48.47%.

The Sobel test necessitates assuming that the parameter AB follows a normal distribution when calculating test statistics, which will result in erroneous results. The bootstrap approach has improved the Sobel test. The coefficient product of the new sample was determined using a bootstrap sample acquired by repeating sampling from the old model. The coefficient product is significant if the confidence interval does not contain 0, indicating that there is a mediation effect, and its test power is larger than the Sobel test. The results of the bootstrap test are displayed in the second column. Bs1 denotes indirect influence, while BS2 denotes direct effect. If zero is omitted, the entire mediation effect is considered. Table 7 demonstrates that the BS1 confidence interval does not contain zero, whereas the BS2 confidence interval does, indicating that there is an indirect but not a direct influence. According to the Sobel and bootstrap tests, the degree of urbanization has a partial mediating influence on the impact of environmental information disclosure on NpH. By limiting the degree of urbanization,

environmental information disclosure will aid water management. This could be due to increased emissions of sulfur dioxide and other toxic chemicals due to urbanization, which raises the likelihood of acid rain and produces the overacidity phenomena in China's water bodies. On the other hand, this research employs land built-up area as a metric for measuring the degree of urbanization. The larger the area of land hardening is, the higher the degree of urbanization. Because the hardened ground has a limited capacity to absorb dirt and scale, rainfall runs directly into rivers, polluting the water. According to the statistics, water quality is better in places with slower urbanization. On the one hand, in rural China, there is less land hardening and more vegetation coverage, which can help to filter water bodies to some extent. Underdeveloped industries and a significant outflow of population produce less pollution, making environmental governance much easier. The initial research demonstrates that environmental protection should not be overlooked throughout the urbanization process, nor should economic development be sacrificed in the name of environmental protection. The government should pursue a dual-route of environmental protection and economic growth.

Conclusions

This study advances previous research in data, indicators, and content by focusing on the influence mechanism and actual effect of government environmental information disclosure on water environmental governance. This research examines whether government environmental information sharing can encourage water quality improvement using a complete third-party dataset.

The findings demonstrate that (1) government environmental information dissemination reduces the NpH value considerably. The more information that is revealed, the more neutral the water quality becomes. (2) There are geographical variances in the impact of environmental information dissemination on water quality pH values. The empirical findings demonstrate that information disclosure has a more substantial positive impact in western China than in eastern and central China. The beneficial influence in heavy industry cities is more substantial than in nonheavy industry cities. The positive effect is more significant in humid areas than in subhumid regions. (3) When the centralized treatment rate of sewage treatment plants is lower, and the natural population growth rate is lower, environmental information disclosure can support water quality to become neutral and boost the favorable effect of environmental information disclosure on NpH. Due to the availability of PITI and water quality data, the data volume in this paper is insufficient, and the sample size may affect the representativeness of the results.

Suggestions for this study can be made based on the above empirical results. The first is that governments should improve their own capacity to disclose environmental data promptly. To give full play to the positive impact of environmental information disclosure on water quality, local governments should constantly improve the environmental information disclosure system and improve the quality and efficiency of environmental information disclosure. Second, compared with non-heavy industry cities, heavy industry cities should pay more attention to environmental information disclosure. From the perspective of urban heterogeneity, heavy industry cities should pay more attention to the timeliness and effectiveness of environmental information disclosure because of the more significant positive impact of environmental information disclosure on water quality. Third, in the urbanization process, attention should be paid to the governance of the water environment. This paper finds that environmental information disclosure can promote water environment governance by reducing the urbanization rate, which also suggests that local governments should attach importance to water environment governance to offset urbanization's negative impact on water environment.

Conflict of Interest

The authors declare no conflicts of interest.

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