

Article

Environmental Health Crises and Public Health Outcomes: Using China's Empirical Data to Verify the Joint Role of Environmental Regulation and Internet Development

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Abstract: Environmental regulation (ER) and internet development (ID) are important options for addressing the environmental health crisis, but the actual impact of both on public health outcomes (PHOs) is still unclear. This study aims to explain how and to what extent China's ER and ID jointly affect PHO. This is especially important for enhancing the degree of coordination between ecosystems and socioeconomic systems and realizing a harmonious symbiotic relationship between human beings and nature. Unlike previous studies, this paper innovatively incorporates ER and ID into the Grossman health production function, establishing a research framework that includes these factors and their impact on PHO. We employed the provincial panel data from China to methodically analyze the importance of ER and ID in responding to environmental health crises and improving public health, so as to close the gaps in the literature. On the basis of the validation of pollution in China endangering PHO and having heterogeneous manifestations, this paper employed a moderating effect model to confirm that ER and ID can mitigate the harm pollution has on PHO. Furthermore, the two have both demonstrated considerable PHO improvement impacts, with the regional heterogeneity of ER's PHO improvement effect being more pronounced. The usage of the spatial effects model proves that ER and ID have significant spatial performance. Furthermore, as the internet develops, the PHO-improving effects of both comprehensive ER and diverse environmental regulatory tools are becoming more pronounced. According to the study's findings, the government should consider ER and ID as major policy alternatives for improving national health. We developed a policy framework that incorporates multiple measures to boost public health protection in the two, and which aids in the exploration and improvement of feasible solutions to improve public health levels.

Keywords: environmental regulation; internet development; environmental pollution; public health; heterogeneity; mechanism analysis



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1. Introduction

Public health is based on the environmental ecosystem's virtuous cycle, which is progressively being disrupted by persistent environmental pollution (EP) issues. EP not only damages environmental media such as air, water, and soil but also creates an interactive cycle between these media and the human body. Harmful substances in the environment can transfer to the human body, posing a threat to public health [1,2]. It has been proven that deteriorating air quality exacerbates the probability of cardiovascular, cerebrovascular, and respiratory diseases, which worsens death rates [3–5]. The Chinese economy has long relied on extensive modes of production. Despite a considerable rise in overall economic production, problems such as low economic development quality, low resource utilization

efficiency, and a deteriorating ecological environment have progressively emerged [6]. The accumulation of conflicts between China's economic expansion and its ecological environment has resulted in substantial challenges in environmental pollution management in China. EP in China exacerbates public health crises. According to the 2015 global disease burden study, 2.4 million people worldwide die from atmospheric PM_{2.5} pollution each year. Chinese residents suffer severe health damage from air pollution, resulting in 1.1 million deaths per year from PM_{2.5} air pollution [7].

Development experience in various countries has proven that relying solely on market forces makes it difficult to maintain benign coordination between the socio-economic system and the environmental ecosystem, resulting in unsustainable economic growth and ineffective pollution control. The important role of ER is gradually becoming apparent and valued. Enterprises are the primary carriers of socioeconomic production activities, delivering material and spiritual goods for people's lives but also causing serious consequences regarding pollutant emissions [8]. Environmental regulatory policies with pollution constraints directly affect the pollution behavior of enterprise production activities, increasing emission costs and encouraging enterprises to rebalance their investment proportions of labor, capital, technology, and other production factors, as well as the scope of business operations [9]. ER can increase production efficiency and minimize pollutant emissions generated by enterprise production activities through innovative compensating effects [10,11]. The pollution constraints generated by regulation and the resulting technical advancement can impact the circulation of factors in the national economic system through the industrial and supply chains, helping to alleviate tension between humans and nature and reducing the threat of EP to national health. ER has grown in importance as a tool for governments throughout the world to decrease pollution and manage environmental health concerns.

However, pollution's effects on health and the pollution-reducing impact of environmental regulatory initiatives are the focus of academic research [12], as pollution is an inevitable logical link in examining ER's health effects. ER, according to some researchers, is an essential approach to reducing pollution [13–15]. A long-standing area of academic interest has been the consequences of environmental contamination on human health. Scholars have utilized different research methods to reveal the relationship between the two from multiple perspectives. The results of studies conducted around the world have amply demonstrated that air pollution is notably connected to a wide range of illness rates, in addition to its impact on life expectancy [16–18]. Furthermore, ER has evolved into various practical forms [19,20]. However, under the framework of environmental health crisis governance, scholars primarily evaluate the economic implications of those regulations, giving little consideration to their effects on human health [21,22]. The research that specifically examines the health implications of ER is still scarce.

In fact, the discussion over the pollution-reduction effects of heterogeneous environmental regulatory tools and the extent to which they improve residents' health levels cannot be limited to analyzing the inherent characteristics of ER tools. Otherwise, the results obtained tend to be one-sided. Three parties are involved in the study of the health impacts of ER: the government, enterprises, and the public [23]. The effective exchange of information among the three parties is crucial for ER to play a role in improving PHO. The internet, with its information sharing capabilities and wide participation, provides them with communication tools and platforms. The increase in internet penetration has resulted in the quick expansion and flow of information, and the disparities in information accessibility among each party have greatly lessened [24]. The continuous information sharing platform created by the ID has a substantial influence on the three parties' behavioral choices [25]. The ER policy information released by the government can be better communicated to enterprises and the public through an internet platform. It is also easier to collect feedback and evaluate the policy effect. This is more helpful in regulating the production behavior of enterprises, creating a favorable living environment for the public and ensuring their health. Scholars generally believe that the emergence of the internet has provided citizens with an information gateway through which they may control their

own health, as well as having improved the comprehensiveness of medical services and the accuracy of treatment programs [26–28]. However, using the internet also increases the likelihood of people being exposed to harmful health-related information and suffering from health or property damage [29,30].

The fourth industrial revolution, characterized by internet technology, has flourished since the start of the twenty-first century. With the gradual advancement of internet infrastructure construction, data information has become an important new production factor in the operations and production processes of businesses in the internet era, as well as an important channel for government public management decisions and public participation in social governance [31,32]. Under the influence of the improvement of internet platforms, in addition to the tripartite interactions of environmental-related information through online platforms, health-related information has also expanded rapidly with the development of the internet [33]. With the advent of remote medical services and substantial changes in media health-reporting methods, an increasing number of individuals are acquiring health knowledge over the internet or using online diagnostic and treatment methods to make judgments about their own health state [34]. ID has increased the accessibility of health resources, significantly reducing the difficulty found by individuals in receiving health knowledge and enjoying high-quality medical resources, and gradually increasing their awareness of self-health management, which aids in the improvement of their personal health level [35,36]. It is necessary and appropriate to include internet factors in the study of the public health effects of ER.

There is currently greater space for study on the topic due to the absence of research examining the connections between ER, the internet, and health. Environmental protection awareness and government management capacity are essential variables influencing the quality of ER. As the internet develops, it could contribute to raising environmental protection awareness and strengthening governmental regulations, both of which are necessary for improved environmental regulation [37]. It is necessary to include the two in the scope of research to examine their health effects. By combing through the relevant literature, we found that scholars have tended to examine the consequences of these factors on the environment and economy under the same framework [38,39]. Existing studies place the analysis of the health effects of the ER and ID in separate research frameworks, neglecting to analyze their impact on health in the same research framework, and a unified research framework on this issue has not yet been truly established. Further research is still needed to figure out how the two differ in their effects on PHO and the study of heterogeneity issues, especially from a macro perspective, to illustrate the relevance of ER and ID in enhancing national health.

To fill this gap, this study integrated ER, ID, and PHO into a unified research framework, based on Chinese provincial-level statistics from 2003 to 2021, by considering the health damage caused by pollution. This study's innovation may be seen in the following aspects: (1) Previous studies mostly measured the macro level of public health with a single indicator represented by the mortality rate, which is somewhat one-sided, so we used multiple indicators to comprehensively evaluate the PHO. (2) A multilevel empirical research framework including mechanism analysis, heterogeneity analysis, and spatial effects is established to study the relationship of all three to overcome the limitations of previous research frameworks. (3) This study compares and analyzes regional heterogeneity from the perspectives of geographical regions, energy structure, and medical resources, and investigates the impact of different regulatory instruments on PHO under the influence of ID. Figure 1 depicts the study's research motivation and logic.

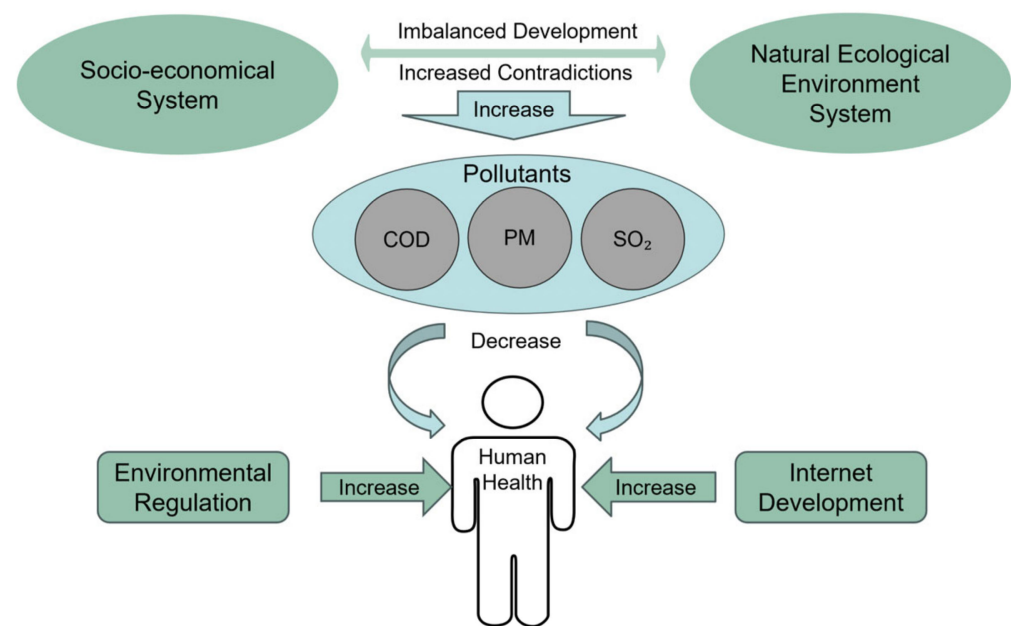


Figure 1. Research logic and motivation.

2. Theoretical Analysis and Research Hypotheses

According to Grossman's health demand model [40], in terms of the attributes of investment goods, health is considered durable capital, and individuals or households can increase their health capital stock by investing in health to compensate for the reduction due to depreciation rates. The depreciation rate indicates the rate at which the stock of healthy capital is reduced by exogenous factors such as age, environment, and genes. The following equation describes the amount of change in healthy capital in the period $t + 1$.

$$H_{t+1} - H_t = I_{ht} - \delta_{ht} H_t$$

where H_{t+1} and H_t represent the stock of residents' health capital in period $t + 1$ and period t , respectively; I_{ht} represents the health investment made by residents in period t to improve their health capital; and δ_{ht} represents the depreciation rate of residents' health capital.

EP increases the probability of disease in the population by affecting the physical environment of health investment and reducing the productivity of individuals through physical exercise, a rational diet, and rest [41]. The productivity of other health investments is not significantly impacted by EP. Therefore, the health depreciation rate equation needs to take the degree of EP into account, expressed as follows:

$$\delta_{ht} = \delta_0 e^{\delta t} P_t^\psi S_t^\phi$$

where the health capital depreciation starting rate is represented by δ_0 ; the age of the residents is represented by t ; P_t is the amount of pollution in the area where the residents reside; and S_t represents other variables affecting the health depreciation rate. δ , φ , and ψ represent the elasticity of the effect of the corresponding variables on the health capital depreciation rate.

Based on the analysis above, population health is recognized to be significantly impacted by pollution. This justifies the inclusion of pollution in the health production function. Based on earlier relevant research and Grossman's health demand model [42,43], we are innovatively attempting to integrate ER and ID into the theoretical analysis of health economics and construct a general theoretical framework to provide a theoretical foundation for this study. We regard the health of the population (H) as a function of the

amount of pollution in the population's environment (P), healthcare expenditures (E), and pollution avoidance behaviors (A), expressed as follows:

$$H = H(P, E, A)$$

Pollution and avoidance behaviors together determine the occurrence of pollution-related diseases, and disease episodes directly contribute to a rise in healthcare costs [44]. It is necessary to include disease factors in the health production function. Furthermore, we hold the view that ER can reduce pollution through the means of mandatory regulations, perfect market mechanisms, and extensive public supervision. Information asymmetry between governments, businesses, and citizens is lessened as a result of the internet's rapid growth in spreading information on EP and ER [45]. Additionally, the internet industry is a technology-intensive tertiary industry. The development of internet industrialization helps to optimize a country's industrial structure, promote industrial transformation, and decrease the share of polluting businesses in the country's economy, as well as the dependence on polluting industries. The integration of the internet with manufacturing can effectively improve manufacturing productivity and reduce pollutant generation and emissions [46]. It has also promoted the recycling of household garbage, which has resulted in new environmental benefits [47]. Based on this, we innovatively introduce ER and ID into the health production function.

$$H = H(E(\alpha), \alpha(P, A), P(\tau ER, ID))$$

where α represents disease, a function of pollution and pollution-avoidance behavior, and an important factor influencing healthcare expenditure.

τ represents the information factor imposed on ER by the ID.

Individual utility is assumed to be derived from health status, consumption, and leisure time. Additionally, it is assumed that personal income, including both wage and non-wage income, is allocated solely towards consumption, medical expenses, and preventive expenses for health damages caused by pollution [44,48]. This study simplifies the analysis of the economic effects component because it concentrates on the public health consequences of ER and ID. The individual utility maximization problem can be expressed as follows:

$$U = \max_{H, C, L} U(H, C, L) = \max_{H, C, L} \ln C + H(E(\alpha), \alpha(P, A), P(\tau ER, ID)) - H_0 - \frac{L^{1+\gamma}}{1+\gamma}, \gamma > 0$$

$$\text{s.t. } C + E + V \leq Y, H \geq H_0$$

where C represents consumption; L represents work time (as opposed to leisure time); V represents precautionary expenditures on pollution that damages health; γ represents the inverse of the Frisch elasticity of labor supply; and H_0 is the bare minimum of health that a person wishes to preserve.

According to theoretical analysis, we integrated ER and ID into the health production function and highlighted their important position in the individual utility function through the last equation. We propose the following hypotheses in this study:

Hypothesis 1. *ER and ID have obvious public health improvement effects and can effectively mitigate the negative public health effects caused by EP.*

Hypothesis 2. *ER and ID have distinct spatial impacts on PHO.*

Hypothesis 3. *The public health impact of both comprehensive and heterogeneous environmental regulatory tools gradually improves with increased ID.*

3. Materials and Methods

3.1. Model Specification

Using the impact of contamination on health as the fundamental relationship, this study builds a benchmark regression model based on Grossman's health production function. The benchmark regression model uses a fixed effects form based on the Hausman test. Its assumption takes into account the endogeneity issues that may arise from missing important explanatory variables, which helps to obtain unbiased and consistent estimators. The benchmark regression model consists of the following equations:

$$PHO_{it} = \alpha_0 + \alpha_1 EP_{it} + \alpha_2 X_{it} + \varepsilon_{it} \quad (1)$$

$$PHO_{it} = \beta_0 + \beta_1 ER_{it} + \beta_2 ID_{it} + \beta_3 X_{it} + \varepsilon_{it} \quad (2)$$

where years and provinces are denoted by t and i , respectively; PHO represents the public health outcomes; EP represents the pollution levels in the environments in which residents live; ER represents the degree of environmental regulation; ID signifies the of internet development level; X represents control variables that include additional aspects influencing inhabitants' health conditions; and the random error term is represented by ε_{it} .

This study creates moderating effect models by introducing interaction terms to illustrate the significance of ER and ID in mitigating the detrimental effects of pollution on PHO .

$$PHO_{it} = \gamma_0 + \gamma_1 EP_{it} + \gamma_2 ER_{it} + \gamma_3 EP_{it} \times ER_{it} + \gamma_4 X_{it} + \varepsilon_{it} \quad (3)$$

$$PHO_{it} = \eta_0 + \eta_1 EP_{it} + \eta_2 ID_{it} + \eta_3 EP_{it} \times ID_{it} + \eta_4 X_{it} + \varepsilon_{it} \quad (4)$$

where $EP \times ER$ represents the interactive term to reflect the moderating influence of regulation on pollution, and $EP \times ID$ represents the interactive term to reflect the moderating impact of ID on EP . The remaining variables' definitions align with the preceding section.

The assumptions of the classical linear regression model do not take into account the possible spatial dependence of the variables, which may give biased estimates and cause "pseudo-regression" problems. Thus, we introduce a spatial weight matrix (SWM) to further construct a spatial model to figure out if ER and ID have a spatial influence on PHO . This model mainly includes three forms: the spatial lag model (SLM), the spatial error model (SEM), and the spatial Durbin model (SDM). The three models can be transformed into each other under different assumptions. Combining the features of other forms, the SDM takes into consideration the fluctuation of the random error component in the model as well as the spatial delays of the explained variable [49]. Based on the test results of the spatial model in this paper, SDM should be selected. The model form is as follows:

$$PHO_{it} = \eta_0 + \rho W \times PHO_{it} + \eta_1 ER_{it} + \eta_2 ID_{it} + \eta_3 X_{it} + \theta_1 W \times ER_{it} + \theta_2 W \times ID_{it} + \theta_3 W \times X_{it} + \varepsilon_{it} \quad (5)$$

where the SWM is denoted by W . This study compares the variations in the spatial effects of ER and ID on PHO impacts under the conditions of various SWM types. We used three types of SWM, including economic distance, inverse geographic distance squared, and the economic-geographical nested matrices. ρ represents the spatial autoregressive coefficient. θ represents the related variable's spatial regression coefficient, which shows the variable's spatial spillover effect.

The previous analysis mentioned that the ID has given a strong impetus to the application of regulations and the dissemination of related information. The growth of the internet has become a significant issue in the study of its public health effects. It is necessary to examine the differences in the impact of comprehensive regulation and heterogeneous regulation tools on PHO at different levels of ID . The traditional threshold effect model, which employs the exogenous sample separation approach, is unable to generate threshold confidence intervals or conduct significance tests. Therefore, we adopted Hansen's panel threshold effect model [50]. The threshold quantity and threshold value of this model are determined by the endogeneity of the sample. The Bootstrap method was used to conduct

threshold significance testing, and the parameter confidence interval was determined based on the asymptotic distribution theory. The threshold effect model used in this study has the following form, which is based on the threshold test results in the following section.

$$PHO_{it} = \alpha_0 + \alpha_1 ER_{it} I(ID_{it} \leq \sigma) + \alpha_2 ER_{it} I(ID_{it} > \sigma) + \alpha_3 X_{it} + \varepsilon_{it} \quad (6)$$

$$PHO_{it} = \beta_0 + \beta_1 CER_{it} I(ID_{it} \leq \sigma_1) + \beta_2 CER_{it} I(\sigma_1 < ID_{it} \leq \sigma_2) + \beta_3 CER_{it} I(ID_{it} > \sigma_2) + \beta_4 X_{it} + \varepsilon_{it} \quad (7)$$

$$PHO_{it} = \eta_0 + \eta_1 MER_{it} I(ID_{it} \leq \sigma) + \eta_2 MER_{it} I(ID_{it} > \sigma) + \eta_3 X_{it} + \varepsilon_{it} \quad (8)$$

$$PHO_{it} = \varphi_0 + \varphi_1 VER_{it} I(ID_{it} \leq \sigma) + \varphi_2 VER_{it} I(ID_{it} > \sigma) + \varphi_3 X_{it} + \varepsilon_{it} \quad (9)$$

where ID is the threshold variable; σ is the value representing the specific level at which the threshold variable is located; CER represents the command-based type; MER represents the market-based type; VER represents the voluntary type; and $I(\cdot)$ represents an indicative function whose function value is 1 if the inequality condition is satisfied, and 0 otherwise.

3.2. Variable Selection

3.2.1. Explained Variable

This study takes the public health outcome (PHO) as an explained variable and selects macro-level indicators to measure the level of public health. Unlike measuring health at the micro level, macro data approximate public health by estimating mortality and life expectancy for statistical reasons. Most of the relevant literature at the macro level uses mortality or life expectancy as a measure of health [51]. Furthermore, vulnerable populations, including the maternal population and children under five, are more likely to experience changes in their health status that reflect changes in external environmental factors [52,53]. Scholars widely recognize the measurement of public health in terms of maternal health or the health of children under the age of five. Disease is the primary source of damage to an individual's health, and some scholars have also used indicators related to prevalence to measure public health [54,55]. Therefore, unlike previous studies that used a single indicator to measure health status, this study innovatively uses comprehensive indicators to measure public health. Given the serious lack of provincial-level life expectancy data in China and to guarantee the study's scientific validity, we selected five indicators from the mortality rate, vulnerable population, and prevalence rate. Furthermore, we adopted the Entropy weight–TOPSIS (EW-T) approach to comprehensively quantify PHO levels. This is a common method for the comprehensive measurement of multiple indicators, and has been widely used by scholars. Because of space limitations, the EW-T method's steps are detailed in the Supplementary Materials.

ArcGIS 10.2 visualization was used to display the measured PHO levels at the provincial level in China in 2003, 2008, 2013, and 2021 (Figure 2). The overall upward trend in PHO levels is evident. Its performance is better in the eastern provinces than in the central and western provinces, but this gap is gradually narrowing. Due to the impact of COVID-19, PHO levels have shown some decline, and the spatial distribution became more dispersed in 2021.

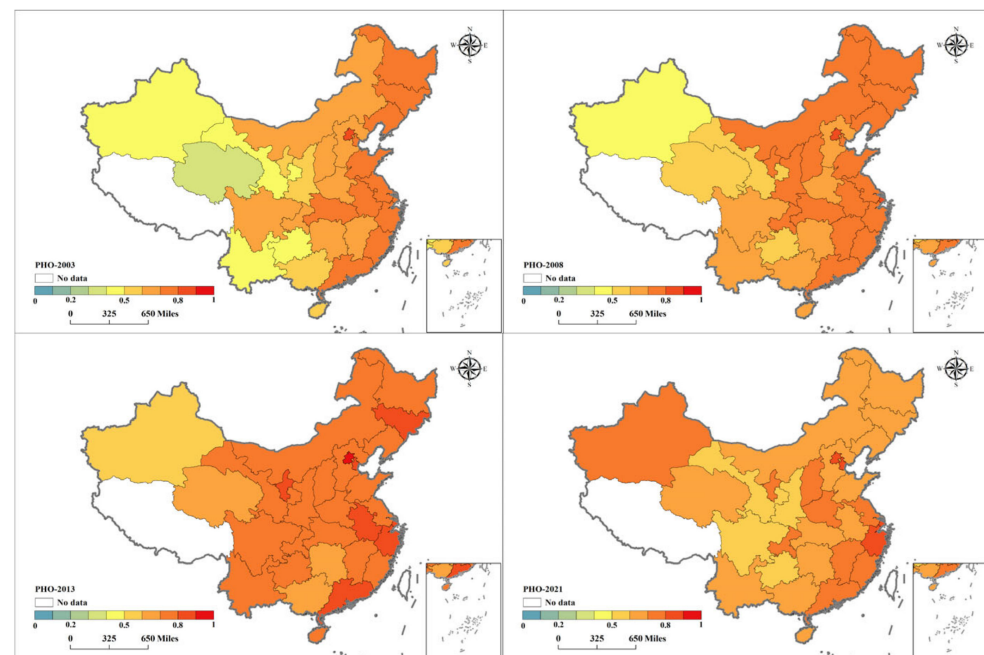


Figure 2. PHO levels in Chinese provinces in 2003, 2008, 2013, and 2021. Note: This map is based on the Standard Map Service website of the Ministry of Natural Resources of China. The drawing approval number is GS (2020) 4619. The base map has not been modified.

3.2.2. Explanatory Variable

Given the significance of pollution, the explanatory variables in this study are categorized into core and auxiliary explanatory variables. In this study, environmental pollution (*EP*) is added as an auxiliary explanatory variable to better explain how *ER* and *ID* affect PHO. The literature currently published suggests two methods for quantifying *EP*: by indicators of emissions of a single type of pollutant or by a composite pollution index. We argue that the forms and sources of pollutants are diverse and that the pathways by which pollutants affect health include not only air but also water and soil. Employing a single indicator to measure *EP* is a rather one-sided approach. Thus, this study selects four pollution category indicators and adopts the *EW-T* approach to measure the pollution degree completely [56,57].

This study focuses on two core explanatory variables: environmental regulation (*ER*) and internet development (*ID*). *ER* is examined from a heterogeneity perspective and is categorized into command, market, and voluntary types [58,59]. Command-based environmental regulation (*CER*) refers to the government taking mandatory measures to intervene in enterprise emission behavior; market-based environmental regulation (*MER*) refers to the government using market mechanisms and market signals to guide enterprises in carrying out energy-saving and emission-reduction activities; and voluntary environmental regulation (*VER*) refers to the public or enterprises taking the initiative to carry out environmental supervision, participating in environmental protection, and carrying out pollution control behavior, which is directly associated with national education. The comprehensive regulation, which is the core explanatory variable, *ER*, is quantified by using the *EW-T* method to combine the indicators of the above three types. The significance of the *ID* lies in its widespread use in people's daily lives, which is well reflected by the internet penetration rate. The state of health is always reflected in people. For the research issue of this study, it would be more suitable to quantify *ID* using the percentage of the population with access to the internet.

3.2.3. Control Variables

We considered other factors affecting public health from economic, social, and demographic aspects and selected urbanization (*Urban*), population agglomeration (*Popul*), population aging (*Aging*), industrial structure upgrading (*Indust*), and economic growth (*GDPP*) as control variables.

The study's variables, indicators, and measuring technique are shown in Table 1.

Table 1. Variable descriptions and measurements.

Types	Variables	Measurement Indicators
Explained variable	<i>PHO</i>	Overall mortality rate
		Perinatal mortality rate
		Maternal mortality rate
		The proportion of children under 5 years old with severe malnutrition
		Class A and B notifiable infectious illness incidence rates
Core explanatory variables	<i>ER</i>	Number of environmental administrative penalties issued during the year (CER)
		Ratio of completed investment in industrial pollution control to industrial value added (MER)
	<i>ID</i>	Average years of education completed by the general population (VER)
Auxiliary explanatory variable	<i>EP</i>	Internet penetration rate
		Industrial sulfur dioxide emissions per CNY 10,000 of GDP
		Industrial wastewater discharge per CNY 10,000 of GDP
		Industrial particulate matter emissions per CNY 10,000 of GDP
Control variables		Industrial chemical oxygen demand emissions per CNY 10,000 of GDP
	<i>Urban</i>	Industrial sulfur dioxide emissions per CNY 10,000 of GDP
	<i>Popul</i>	Industrial wastewater discharge per CNY 10,000 of GDP
	<i>Aging</i>	Industrial particulate matter emissions per CNY 10,000 of GDP
	<i>Indust</i>	Industrial chemical oxygen demand emissions per CNY 10,000 of GDP
Control variables		Industrial sulfur dioxide emissions per CNY 10,000 of GDP
	<i>Urban</i>	Industrial wastewater discharge per CNY 10,000 of GDP
	<i>Popul</i>	Industrial particulate matter emissions per CNY 10,000 of GDP
	<i>Aging</i>	Industrial chemical oxygen demand emissions per CNY 10,000 of GDP
	<i>Indust</i>	Industrial sulfur dioxide emissions per CNY 10,000 of GDP
	<i>GDPP</i>	Industrial wastewater discharge per CNY 10,000 of GDP

3.3. Data Sources

The relevant statistics yearbooks that China and the provinces officially published between 2004 and 2022, as well as the National Bureau of Statistics of China (<http://www.stats.gov.cn/>, accessed on 8 June 2024), provided the data for this study. Because of the wide range of indicators in this study, interpolation was utilized to fill in the missing values for particular indicators in order to create balanced panel data. This study uses 2003 as the base period and deflates it using the appropriate price index to exclude the impact of inflationary forces on price variables. The study covers 30 Chinese provinces. Due to a high number of missing data or difficulties in obtaining data, Xizang, Hong Kong, Macao, and Taiwan were not included. Logarithms were used for some variables to avoid the effect of heteroscedasticity.

4. Results

4.1. Benchmark Regression Results

We considered the fact that this research uses multiple explanatory and control variables, and that there may be a problem of multicollinearity, leading to biased regression results. There is no significant multicollinearity issue in this study, as indicated by the test's VIF score of 3.37, which is far less than the crucial value of 10. Furthermore, we used a panel data fixed-effect model for benchmark regression analysis, according to the Hausman test findings (Table 2).

Table 2. Results of the benchmark regression estimation.

Variables	Model (1)	Model (2)		
		(1)	(2)	(3)
<i>EP</i>	−0.1194 *** (−4.30)			
<i>ER</i>		0.1704 *** (4.05)		0.1228 *** (2.95)
<i>lnID</i>			0.0389 *** (6.48)	0.0353 *** (5.81)
<i>lnUrban</i>	0.1709 *** (5.80)	0.1895 *** (6.67)	0.1133 *** (3.62)	0.1044 *** (3.35)
<i>lnPopul</i>	0.1884 *** (4.97)	0.1686 *** (4.41)	0.1128 *** (2.90)	0.1070 *** (2.77)
<i>Aging</i>	−0.0170 *** (−10.97)	−0.0165 *** (−10.50)	−0.0173 *** (−11.49)	−0.0166 *** (−10.91)
<i>Indust</i>	0.0122 (1.47)	0.0094 (1.13)	0.0093 (1.14)	0.0071 (0.89)
<i>lnGDPP</i>	0.1334 *** (5.12)	0.1363 *** (5.23)	0.0271 (0.88)	0.0347 (1.13)
Constant	−2.0551 *** (−7.49)	−2.1141 *** (−7.74)	−0.5563 (−1.48)	−0.5869 (−1.57)
<i>R</i> ²	0.6991	0.7249	0.6884	0.7043
<i>F</i>	105.71 ***	105.00 ***	113.98 ***	100.35 ***
Hausman	81.15 ***	67.47 ***	43.86 ***	39.87 ***

Note: The t-values are in parentheses; significance at the 1%, statistical levels is indicated by the letters ***.

PHO is considerably harmed by EP, according to the results of model (1), where the *EP* coefficient is shown to be significantly negative. China's provincial-level data provide empirical evidence of the major health crisis that EP poses to the country's citizens. This statement is in accordance with both the findings of the established literature and the actual situation of the increased environmental health crisis in China [60,61]. Given the robustness of the outcomes, we regressed model (2) using a stepwise placement of the core explanatory variables. The two core explanatory variables brought about a significant improvement in PHO, as seen by the positive coefficients of *ER* and *lnID* in columns (1) through (3), which passed the 1% significance level test. The results of Pei et al. [62] and Hou et al. [63] were consistent with this conclusion, demonstrating that both ER and ID can still provide realistic guarantees for improving national health when included in the same research framework. The empirical results of models (1) and (2) broadly agree with the predictions, and the regression results for the control variables are extremely consistent. Urbanization and populace density have a favorable effect on PHO, whereas aging has a detrimental effect. The industrial structure upgrading coefficient is favorable but not significant statistically, and the economic development coefficient is positive but its significance is unstable.

4.2. Moderating Effect Test

We further discussed whether ER and ID may lessen the detrimental consequences (Table 3). The interaction terms' coefficients in the regression findings of models (3) and (4) are considerably positive. The coefficients of *EP* exhibit substantial negative values, agreeing with the outcomes of the benchmark regression. According to the interaction terms and coefficients of *EP* variables, we found that the connection between pollution and PHO is positively moderated by ER and ID. In other words, the two can effectively reduce the damage to public health posed by pollution and are important tools for governments and individuals to deal with environmental health crises. This also partially justifies the general theoretical framework presented in this study. The benchmark regression and moderating effects test results prove hypothesis 1.

Table 3. The results of the moderating effect test.

Variables	Model (3)	Model (4)
EP	−0.2527 *** (−3.71)	−0.3472 *** (−5.46)
ER	0.0232 (0.34)	
EP × ER	0.5397 ** (2.36)	
lnID		0.0197 *** (2.76)
Ep × lnID		0.0768 *** (4.22)
Controls	Yes	Yes
Constant	−1.9701 *** (5.12)	−0.1936 (−0.15)
R ²	0.5581	0.5872
F	83.99 ***	94.59 ***

Note: The t-values are in parentheses; significance at the 1% and 5% statistical levels is indicated by the letters *** and ** respectively.

4.3. Regression Results for Regional Heterogeneity

Considering the vast geographical area of China and the significant regional differences among provinces, the roles of the public health effects of EP, ER, and ID may be different. Based on previous studies [64,65], differences in energy structure and medical resources are also important factors that may contribute to the heterogeneous regression results from the perspective of environmental health. No scholars have yet investigated empirical data to test this issue. To fill the gaps of previous studies and further improve the multilevel empirical analysis framework, we grouped the samples according to three dimensions, namely geographic region, energy structure, and healthcare resources, respectively.

The geographic region dimension is divided into two groups: the eastern provinces and the central and western provinces. Due to the long-standing coal dominance in China's energy structure, the proportion of coal in overall energy consumption can directly reflect the degree of energy structure optimization [66,67]. The median of the average coal share of the total energy consumed throughout the study period is the criterion that is used. Above the median, a province is considered to have a high share of coal, and below the median, a province is considered to have a low share of coal. Additionally, we used the EW-T method to synthesize a composite indicator to assess the health resource endowment of each province more comprehensively. The indicators cover various types of healthcare resources, including healthcare beds, healthcare institutions, healthcare staff, and local financial expenditure on healthcare [68]. The median of the mean healthcare resource endowment levels over the study period was used as the boundary in this study. Those above the median are classified as having a high healthcare resource endowment, while those below are classified as having a low healthcare resource endowment.

The heterogeneity regression findings of model (1) are displayed in Table 4. The empirical finding was that the detrimental impact of pollution is unaffected by the different classifications, indicating that pollution's detrimental effects on health are robust. Comparing provinces geographically, the eastern provinces are more severely affected by EP's detrimental impacts on PHO than are the middle and western provinces. The economically developed eastern provinces have undergone China's reform and opening-up processes. All kinds of production activities and a large number of people are concentrated in these regions, which makes the contradictions and conflicts between socio-economic systems and natural ecosystems more pronounced. Meanwhile, based on the development experience of the eastern provinces, the central and western provinces have the advantage of backwardness. These regions emphasize the improvement of the quality of economic development and integrated planning for economic development, environmental quality improvement,

and public health protection, which weakens the negative effect of EP on PHO. According to the energy structure grouping, provinces with a large coal share have greater pollution, which has a detrimental effect on public health. Pollutant emissions are efficiently reduced when the share of energy sources that are highly polluting decreases and there is a move towards cleaner energy sources. This lessens the detrimental impacts of contamination on general health. In terms of medical resource endowment, provinces with higher medical resource endowments are more exposed to the harmful effects of pollution on human health. Efficiency and rationality should be the guiding principles for allocating medical resources. It should better serve people with severe environmental health crises to fully utilize the effectiveness of medical resources. China's medical resources are concentrated in the eastern provinces to alleviate the severe public health damage.

Table 4. Regression results for heterogeneity based on model (1).

Variables	Grouping Dimension (1)		Grouping Dimension (2)		Grouping Dimension (3)	
	Eastern Provinces	Central and Western Provinces	High Coal Proportion	Low Coal Proportion	High Medical Resource Endowment	Low Medical Resource Endowment
<i>EP</i>	−0.1885 *** (−4.46)	−0.0875 ** (−2.47)	−0.1520 *** (−4.72)	−0.1180 ** (−2.50)	−0.1464 *** (−3.20)	−0.0658 ** (−2.14)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−1.9187 *** (−4.72)	−2.2458 *** (−4.71)	−0.9531 * (−1.94)	−3.2796 *** (−6.96)	−2.4165 *** (−6.68)	−1.8008 *** (−4.49)
R ²	0.6186	0.5708	0.6227	0.5434	0.5950	0.5576
F	51.90 ***	74.46 ***	72.63 ***	52.36 ***	64.65 ***	55.47 ***

Note: The t-values are in parentheses; significance at the 1%, 5%, and 10% statistical levels is indicated by the letters ***, **, and *, respectively.

The heterogeneity regression findings of model (2) are displayed in Table 5. The robustness of the results is partially indicated by the fact that the various groups do not modify the conclusion that ER and ID have a favorable influence on PHO. The change in the significance of the *ER* coefficient for model (1) is consistent with the shift in the *EP* coefficient's significance for each group. By analyzing the results of model (1), we find that the threat to PHO from EP is more prominent in the eastern provinces, the provinces with a high-coal-share type of energy structure, and the provinces with a high healthcare resource endowment. Governments in these regions implement stronger environmental regulatory measures to reduce the pollution harm suffered by their residents, which makes the coefficient of the effect of ER on PHO in model (2) more significant. This suggests that ER and pollution are closely related. ER is an essential approach the Chinese government uses to lower pollution and strengthen environmental health governance. The coefficients of *lnID* pass the significance level test of 1% across all types of groupings. However, the t-value of *lnID* in central and western provinces is significantly higher than that in eastern provinces, indicating that the improvement effect of ID on PHO in central and western provinces is more significant. The ID greatly improves the efficiency of information transmission. This shortens the distance between people and high-quality medical resources, as well as alleviating various constraints caused by geographical distance. The central and western provinces have a wider geographical area, and high-quality medical resources are relatively scattered. Their internet infrastructure construction lags behind the eastern provinces, but this also means that the positive marginal PHO output brought by ID is greater. In recent years, the speed of ID has accelerated in the central and western provinces, and the awareness of its residents to use the internet to enhance health management has increased significantly. In addition, the empirical results indicate that regional differences in energy structure and healthcare resource endowment do not produce significant changes in PHO improvement effects of ID.

Table 5. Regression results for heterogeneity based on model (2).

Variables	Grouping Dimension (1)		Grouping Dimension (2)		Grouping Dimension (3)	
	Eastern Provinces	Central and Western Provinces	High Coal Proportion	Low Coal Proportion	High Medical Resource Endowment	Low Medical Resource Endowment
ER	0.2376 *** (4.90)	0.0947 * (1.74)	0.1709 *** (2.82)	0.1067 * (1.85)	0.1624 *** (2.81)	0.1295 ** (2.34)
lnID	0.0202 *** (2.75)	0.0570 *** (6.95)	0.0369 *** (4.18)	0.0291 *** (3.37)	0.0371 *** (4.28)	0.0327 *** (3.88)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−0.8074 (−1.34)	−0.6875 (−1.40)	−0.7867 (−1.48)	−1.5357 ** (−2.35)	−1.1671 ** (−2.46)	0.0740 (0.12)
R ²	0.6395	0.6322	0.6402	0.5593	0.6276	0.5853
F	48.40 ***	82.26 ***	66.84 ***	47.69 ***	63.33 ***	53.03 ***

Note: The t-values are in parentheses; significance at the 1%, 5%, and 10% statistical levels is indicated by the letters ***, **, and *, respectively.

4.4. Spatial Effect Test

The global Moran's *I* index for *ER*, *lnID*, and *PHO* for the years 2003–2021 is calculated by introducing the inverse geographic distance squared matrix. The index for the variables *PHO* and *lnID* is significantly positive for the study period, and the index for *ER* is also considerably positive for all years except 2021, when it is insignificant (Table 6). This suggests that *ER*, *ID*, and *PHO* all have significant positive spatial correlations. The spatial implications of *ER* and *ID* on *PHO* must be explored. Moreover, few scholars incorporate spatial factors into health-related research, which further emphasizes the innovative character of this study.

Table 6. Results of the global Moran's *I* test.

Year	PHO		ER		lnID	
	Moran's <i>I</i>	Z-Value	Moran's <i>I</i>	Z-Value	Moran's <i>I</i>	Z-Value
2003	0.487 ***	5.460	0.179 ***	2.271	0.248 ***	3.037
2004	0.467 ***	5.298	0.263 ***	3.170	0.303 ***	3.594
2005	0.441 ***	5.024	0.184 ***	2.317	0.315 ***	3.696
2006	0.448 ***	5.137	0.196 ***	2.435	0.322 ***	3.742
2007	0.401 ***	4.663	0.230 ***	2.786	0.294 ***	3.453
2008	0.335 ***	3.973	0.291 ***	3.461	0.228 ***	2.741
2009	0.341 ***	4.051	0.290 ***	3.435	0.247 ***	2.939
2010	0.303 ***	3.629	0.325 ***	3.813	0.285 ***	3.316
2011	0.262 ***	3.173	0.238 ***	2.967	0.230 ***	2.751
2012	0.211 ***	2.661	0.213 ***	2.780	0.226 ***	2.713
2013	0.196 ***	2.494	0.203 ***	2.705	0.231 ***	2.764
2014	0.236 ***	2.932	0.320 ***	3.997	0.216 ***	2.607
2015	0.241 ***	2.947	0.261 ***	3.200	0.191 ***	2.341
2016	0.224 ***	2.752	0.327 ***	4.147	0.216 ***	2.620
2017	0.296 ***	3.473	0.421 ***	5.118	0.213 ***	2.604
2018	0.255 ***	3.030	0.462 ***	5.364	0.200 ***	2.484
2019	0.339 ***	3.887	0.427 ***	4.988	0.170 **	2.173
2020	0.268 ***	3.189	0.416 ***	4.908	0.127 **	1.706
2021	0.248 ***	2.966	−0.021	0.163	0.141 **	1.840

Note: Significance at the 1% and 5% statistical levels is indicated by the letters *** and ** respectively.

We used LR and Wald tests to determine which spatial effects model to choose. We introduced three kinds of SWM to conduct spatial effects analysis for the purpose of examining the robustness of spatial effects and comparative analysis. The tests show the rejection of the SLM and SEM forms (Table 7), indicating that the SDM is more suitable. Therefore, we used model (5) to perform the spatial effects regression (Table 8). *PHO*'s spatial autocorrelation coefficient ρ was significantly positive, indicating that public health levels in adjacent provinces

are spatially dependent. The health of people living in nearby provinces is positively impacted by improvements in public health within the province. The coefficients for both *ER* and *lnID* were positive. The $W \times ER$ coefficient was significantly positive, while $W \times \ln ID$ had a positive but insignificant coefficient. Spatial lag terms of both explanatory and dependent variables were taken into account by SDM [69]. The regression coefficients also incorporate the impacts of explanatory factors in the home province and neighboring provinces on the dependent variables. This might cause the regression findings to be biased. Examining spatial spillovers via this approach may lead to biased outcomes. Thus, the regression coefficients displayed in Table 8 may not accurately represent the explanatory factors' marginal impacts on the dependent variables.

Table 7. Results of the spatial effects model test.

Test Type	Models	Inverse Geographic Distance Squared	Economic Distance	Economic–Geographical Nested
LR test	SLM	26.53 ***	37.60 ***	49.82 ***
	SEM	16.11 **	41.97 ***	21.53 ***
Wald test	SLM	21.29 ***	31.67 ***	20.37 ***
	SEM	14.76 **	45.14 ***	20.31 ***
	Hausman	48.07 ***	38.83 ***	71.24 ***

Note: Significance at the 1% and 5% statistical levels is indicated by the letters *** and ** respectively.

Table 8. Results of SDM regression.

Variables	Inverse Geographic Distance Squared	Economic Distance	Economic–Geographical Nested
<i>ER</i>	0.1480 *** (4.10)	0.1445 *** (4.16)	0.1451 *** (3.92)
$W \times ER$	−0.2078 *** (−3.25)	−0.1993 *** (−4.57)	−0.1708 *** (−2.67)
<i>lnID</i>	0.0229 ** (2.23)	0.0254 ** (2.47)	0.0244 ** (2.27)
$W \times \ln ID$	0.0058 (0.45)	−0.0066 (−0.59)	0.0136 (0.98)
Controls	Yes	Yes	Yes
ρ	0.6637 *** (14.92)	0.4831 *** (14.24)	0.6506 *** (13.28)
R^2	0.5732	0.5840	0.5797
<i>Log-likelihood</i>	1144.6948	1147.9694	1132.5494

Note: The t-values are in parentheses; significance at the 1% and 5% statistical levels is indicated by the letters *** and ** respectively.

This study adopts the partial differential approach to decompose the spatial effects (Table 9). *ER* and *lnID* have considerable favorable direct impacts, suggesting that the province's public health level is influenced by its own ID and ER. Due to the considerable negative indirect effect of *ER* under the parameters of the inverse geographic distance squared matrix and the economic distance matrix, ER in this province may have detrimental spatial spillover effects on PHO in adjacent provinces. When the province increases ER, local businesses bear more of the environmental expenses, especially polluting companies that face stricter emission constraints. Enterprises may transfer highly polluting production links or the entire industrial chain to neighboring provinces with weaker ER intensity in order to reduce environmental costs, which will undoubtedly increase the environmental health crisis and the citizens' health burden in neighboring provinces. The indirect effect of *lnID* is notably positive under the conditions of the economic–geographical nested matrix and the inverse geographic distance squared matrix. This implies that the province's ID has a favorable geographical spillover impact on other provinces' PHO. As the province's ID continues to advance, surrounding provinces' processes of internet popularization and digital economy development are accelerated by the internet technology

spillover impact and the digital economy demonstration effect. Additionally, the province's health resources are gradually shared with neighboring provinces through the ID, helping residents of neighboring provinces improve their health conditions. Endogeneity problems may arise if the SWM contains economic factors that change over time [70,71]. For *ER* under the economic–geographical nested matrix and *lnID* under the economic distance matrix, the indirect effect coefficients' signs for both are in line with the above analysis but may have been influenced by endogenous economic factors, resulting in a lack of significance. The *ER* coefficients corresponding to the direct and indirect impacts are both significant and opposite in sign, and the indirect effect's absolute value is greater than the direct effect's, which leads to the negative and weakened significance of the total effect. The overall effect of *lnID* is considerably positive because both its direct and indirect effects are significant and the coefficients have the same sign. In summary, hypothesis 2 is proven.

Table 9. Results of spatial effect decomposition.

Variables	Spatial Effect Decomposition	Inverse Geographic Distance Squared	Economic Distance	Economic–Geographical Nested
<i>ER</i>	Direct effect	0.1291 *** (3.26)	0.1172 *** (3.03)	0.1333 *** (3.32)
	Indirect effect	−0.3225 *** (−1.86)	−0.2273 *** (−3.09)	−0.2212 (−1.35)
	Total effect	−0.1934 (−1.01)	−0.1101 (−1.14)	−0.0879 (−0.49)
<i>lnID</i>	Direct effect	0.0263 *** (2.76)	0.0263 *** (2.85)	0.0288 *** (2.89)
	Indirect effect	0.0613 ** (2.39)	0.0107 (0.80)	0.0828 *** (2.94)
	Total effect	0.0875 *** (3.41)	0.0370 *** (2.79)	0.1116 *** (3.96)

Note: The t-values are in parentheses; significance at the 1% and 5% statistical levels is indicated by the letters *** and ** respectively.

4.5. Threshold Effect Analysis

Information has become a crucial instrument for connecting governments, businesses, and individuals. We innovatively considered ID as a threshold variable and employed a threshold model to investigate the impact of both varied regulation tools and comprehensive *ER* on *PHO*. The threshold effect test results are displayed in Table 10. And we plotted the likelihood ratio function for each variable (Figure 3). It is determined that a single-threshold model can be used to examine the public health consequences of market-based, voluntary, and comprehensive types, while a double-threshold model can be used to examine the impact of command-based types on *PHO* (Table 11).

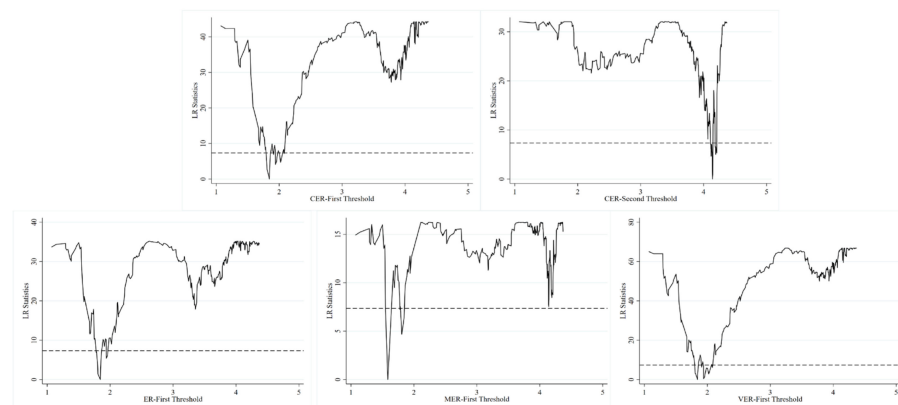


Figure 3. The likelihood ratio function of threshold variables.

Table 10. Results of the threshold effect test.

Explanatory Variables	Threshold Quantity	F-Value	p-Value	Critical Value			Threshold Value	95% Confidence Interval
				10%	5%	1%		
ER	Single	38.67	0.0233	26.7087	31.5770	43.4597	1.8448	[1.7990, 1.8479]
	Double	8.76	0.7367	24.8407	30.8644	40.5401	4.0673	[3.8279, 4.0690]
	Triple	7.61	0.7833	21.1479	25.7204	34.0103	3.3534	[3.1986, 3.3755]
lnCER	Single	49.22	0.0367	38.8772	44.6485	58.8148	1.8448	[1.7990, 1.8479]
	Double	32.52	0.0767	31.0225	35.3533	49.7380	4.1415	[4.1230, 4.1431]
	Triple	9.46	0.8033	27.8701	34.3783	46.6562	3.9318	[3.7617, 3.9396]
MER	Single	53.30	0.0000	20.1417	26.8086	40.0607	1.8139	[1.7849, 1.8448]
	Double	16.46	0.1800	21.1566	24.7829	36.9200	2.1331	[2.0298, 2.1338]
	Triple	9.47	0.6767	28.0747	33.2742	42.0182	4.1415	[4.1197, 4.1431]
lnVER	Single	74.70	0.0000	37.8205	41.5160	61.0776	1.9407	[1.9330, 1.9592]
	Double	30.96	0.1333	32.5320	37.4536	51.8556	4.1415	[4.1230, 4.1431]
	Triple	14.16	0.7767	33.1631	36.2351	51.4784	2.4668	[2.0240, 2.4929]

Table 11. Regression results for the threshold effect.

Variables	Model (6)	Model (7)	Model (8)	Model (9)
ER (lnID ≤ 1.8448)	0.0392 (0.63)			
ER (lnID > 1.8448)	0.2377 *** (5.07)			
lnCER (lnID ≤ 1.8448)		−0.0016 (−0.57)		
lnCER (1.8448 < lnID ≤ 4.1415)		0.0051 ** (2.00)		
lnCER (lnID > 4.1415)		0.0030 (1.14)		
MER (lnID ≤ 1.8139)			−0.1005 *** (−5.60)	
MER (lnID > 1.8139)			−0.0356 *** (−3.54)	
lnVER (lnID ≤ 1.9407)				0.0890 (1.54)
lnVER (lnID > 1.9407)				0.1161 ** (1.99)
Controls	Yes	Yes	Yes	Yes
Constant	−0.6789 * (−1.88)	−2.1969 *** (−7.85)	−0.5999 * (−1.67)	−1.1549 *** (−3.56)
R ²	0.6080	0.5960	0.6185	0.6160
F	82.21 ***	87.05 ***	85.92 ***	94.65 ***

Note: The t-values are in parentheses; significance at the 1%, 5%, and 10% statistical levels is indicated by the letters ***, **, and *, respectively.

When the state of ID is below 1.8448, the results of model (6) indicate that ER's coefficient is positive but not significant. This is due to the inefficiency of environment-related information dissemination, which fails to match the ER level. Environment-related information is still highly time-lagged and regionally limited. Similarly, the regression findings of model (9) show that when the degree of ID is beyond the threshold of 1.9407, the public health effect coefficient of lnVER becomes significant. The subject of VER is the public in society. Convenient and rapid access to information is crucial for the public, and the information platform provided by the development of the internet not only meets their needs for environmental information but also provides them with effective ways to

participate in environmental governance and supervision, such as online hearings and the emerging self-media platform represented by TikTok.

CER aims to restrict businesses' arbitrary emission behavior by raising their environmental costs through mandatory laws or administrative regulations. The effectiveness of such regulation is based on the popularization of environment-related laws and administrative regulations. The deterrent effect of corresponding penalties for non-compliant enterprises needs to be expanded through effective information dissemination. ER does not appear to promote PHO when the degree of internet growth is less than 1.8448. When it is in the range of [1.8448, 4.1415], the information element of ID increases the CER's health improvement effect. When it surpasses 4.1415, the health impact of the command-based type is not significant enough. With the internet's further development, more convenient and practical health management modes have emerged, such as internet hospitals and pharmaceutical e-commerce supply chains. These modes provide effective support for residents to strengthen the self-management of their health and improve their own health, which may obscure the impacts of CER. In addition, the rise in internet usage increases the demands on internet regulation, and the lack of regulation tends to create false rumors or accelerate the spread of illegal information, which can weaken the effectiveness of its significant public health effects.

The *MER* coefficients are all significantly negative. However, its coefficient absolute value decreases significantly when the degree of ID exceeds 1.8139. This suggests that the ID drive is gradually mitigating the detrimental effects of *MER* on PHO [72]. China primarily employs CER as its policy tool and supplements it with *MER*. Due to imperfect supporting policies and market mechanisms, the full potential of *MER* to reduce pollution and enhance health has not been realized. The demarcation line of regional markets, formed by information barriers, is becoming increasingly blurred due to the influence of ID. The market signals released by *MER* expand the scope of influence through the internet, guiding enterprises to restrain their own pollution-emitting behavior and to make rational production and investment decisions. To some extent, this mitigates the negative public health effects of *MER* under an unsound market mechanism. As the Chinese government continues to promote market mechanism reform and improve the institutional system for ID, the policy effect of *MER* can break through the "inflection point" and show its health improvement effect. In summary, hypothesis 3 is proven.

4.6. Robustness Checks

A heterogeneity regression analysis based on differences in geographic regions, energy structures, and medical resource endowments was carried out. The robustness of the results is demonstrated by the regression findings' consistency with the benchmark regression results. This study further discusses the robustness by replacing the core explanatory variables' indicators, adding control variables, changing sample intervals, and changing estimation methods. The robustness checks used were as follows.

(1) Replacement of indicators for measuring ER and ID. From the standpoint of environmental governance performance, the centralized sewage treatment rate, overall industrial solid waste utilization rate, and greening coverage of built-up areas were selected to calculate the new ER indicators. The proportion of mobile phone users per 100 people was selected to measure the ID level from the perspective of internet use. (2) Considering that the omission of the control variables may lead to the results not being robust, we further sorted out other factors affecting PHO and included the per capita healthcare consumption expenditure of the population and the number of patents granted per 10,000 people as control variables. (3) Given the special characteristics of municipalities in terms of economic development, policy support, and government behavior compared to other provinces, we re-ran the regressions after excluding the samples of four municipalities, namely Beijing, Shanghai, Chongqing, and Tianjin, to illustrate the robustness. (4) Unrobust regression results can also emerge from the presence of outliers. We regressed the variables to check robustness after bilateral 1% shrinkage of the tails to eliminate the effect of outliers. (5) We

replaced the estimation method to deal with possible endogeneity issues. A system GMM approach was used to re-estimate the impact of ER and ID on PHO.

The robustness test findings are displayed in the Supplementary Materials. The outcomes from the above robustness test methods agree with the previous results, demonstrating the stability of the benchmark regression outcomes. It was not a coincidence that the coefficients on ER and ID variables were significant.

5. Conclusions and Policy Implications

5.1. Conclusions

Unlike previous studies that used a single indicator to measure PHO in a one-sided way, this study uses Chinese provincial panel data to provide a reasonable measure of public health at the macro level. The study innovatively incorporates ER and ID into the health production function to analyze its rationality from the micro level. Existing studies tend to discuss the impacts of EP and the internet on health separately, without establishing a unified research framework for the two's impact on PHO. This study attempts to rectify the shortcomings of previous studies in this area by providing an empirical framework for analyzing the public health effects of the ER and ID. Specifically, based on the verification of the health damage of EP and its heterogeneous characteristics, this study examines the moderating effects of the two on the link between pollution and PHO. Then, we compared and analyzed the diverse features of their public health effects using the fixed effects model. This study examines their spatial effects on public health using SDM. Under the influence of varying degrees of internet development, the health consequences of comprehensive ER and diverse environmental regulatory instruments were examined using a panel threshold effect model. The following are the study's conclusions.

1. PHO is significantly harmed by EP. The extent of health damage caused by pollution varies according to geographic regions, energy structure, and the level of medical resources. Eastern provinces, provinces with a significant coal share, and provinces with substantial medical resource endowments are more severely affected by pollution's detrimental effects on public health. ER and ID can effectively mitigate the adverse effects. There is a positive moderating effect.
2. PHO benefits directly from ER and ID. The significance of ER's impact on PHO is consistent with the significance of the health damage of EP under the grouping conditions of geographic region, energy structure, and level of medical resources. Meanwhile, ID has a greater impact on PHO in central and western provinces, and its regional variability in terms of energy structure and medical resource endowment is not apparent.
3. ER, ID, and PHO exhibit positive spatial agglomeration. Specifically, there is spatial agglomeration in some provinces at higher levels and spatial agglomeration in some provinces at lower levels. ER has a negative spatial spillover effect on PHO. Its intensity grows in adjacent spatial units, increasing the unit's public health burden. Conversely, improvements in internet use have a beneficial spatial spillover impact on public health. An increase in its level in neighboring spatial units will help to improve the unit's public health.
4. With an increasing ID level, the impact of both comprehensive ER and heterogeneous regulatory tools on PHO gradually improves. The impact of VER and comprehensive ER on PHO has a single threshold. The influence of their significance increases as ID progresses beyond a certain threshold. There is a double threshold for the public health effects of CER, which is also characterized by an increase in the significance of the effects as the internet develops. Increased internet growth significantly lessens the detrimental consequences of MER on PHO.

5.2. Policy Implications

1. Establishing and improving a governance system that synergistically combines multiple types of environmental regulatory tools with regional characteristics. Local

governments should optimize the combination and implementation intensity of various regulatory tools to reduce pollutant emissions and environmental health crises for residents. Currently, China's central government has proposed the goal of "carbon peaking and carbon neutrality", which puts new demands on environmental regulatory measures. In the new situation, various regulatory measures should be taken to further guide enterprises and the public to participate in the process of environmental health management, such as improving low-carbon transformation regulations, accelerating the establishment of carbon emission trading markets, and creating carbon neutrality special bonds. Meanwhile, local authorities ought to strengthen their support for the clean energy industry and medical care and promote the energy structure's optimization and the improvement of the supply capacity of medical resources so as to improve the public health situation.

2. Further increase internet penetration to improve health resources' accessibility. The internet has expanded rapidly in China in recent years, largely due to the implementation of the "Broadband China" strategy in 2013. Nevertheless, the extent of internet coverage in western China and rural areas remains limited. Government agencies should speed up the construction of internet infrastructure in favor of less developed regions to narrow the "digital gap" with developed eastern regions. The policy of internet speed-up and cost reduction should be actively promoted to improve the enthusiasm of residents for using the internet, so that the coverage of high-quality health resources will benefit residents in underdeveloped areas. In addition, it should enrich the medical application scenarios of the internet and establish internet medical service platforms such as Alibaba Health Network Hospital to improve the accessibility of medical resources and the convenience of medical insurance reimbursement, so as to provide better medical services and health security for residents.
3. Strengthen regional cooperation and improve cross-regional coordination mechanisms for ER and ID. The border pollution problem poses a serious threat to the health of local residents. Uncoordinated ER and poor communication of information are the main reasons for this problem. Local governments should continue to promote the construction of internet platforms to share environmental information and then jointly monitor the overall environmental quality. Based on analyzing environmental information, cross-regional cooperation in environmental enforcement should be actively carried out. Through the construction of industrial internet platforms, Beijing, Tianjin, and Hebei provinces of China have taken collaborative governance measures and achieved positive results in the prevention and control of air pollution. At the same time, regions should encourage the creation of a database that facilitates the sharing of corporate data and enhance the coordination of ER to decrease rent-seeking opportunities for polluting companies and to avoid institutional loopholes resulting from differences in policy intensity, which could lead to the problem of pollution transfer, the shifting of environmental health crises, and the exacerbation of inequalities in population health between regions.
4. Actively explore the integrated development path of the internet and ER, and embed the internet into ER tools. We find that ID facilitates the PHO improvement effects of various types of ER. Therefore, the government should accelerate the promotion of internet technology so that it has the basic conditions for integration with ER. It should use the internet as a basis to promote the intelligence and digitization of the application of various environmental regulatory tools, forming an "Internet Plus Regulation" model. Through online channels such as portal websites, microblogs, TikTok, etc., the government should promptly release the policy details of the CER and MER. This will also provide a convenient online channel for the public to report pollution behavior and guide them to use the internet to participate more deeply in environmental governance. Government departments should further use internet technology to analyze public opinion and deal with environmental problems reflected

by the public by improving the network response mechanism to strengthen the effect of VER.

5.3. Limitations and Future Research

It should be mentioned that this study has some limitations. First, in contrast to general health-related research that focuses on individual health samples, this study employs macro-statistical data to analyze public health improvement at the provincial level. Macro-statistical data are less detailed than individual survey data, which results in a less precise analysis of the corresponding empirical results. Nevertheless, in the context of this study, the use of macro-statistics is essential for public health issues in order to ensure that the results are both meaningful and reliable. Second, the mechanism variables in this study were limited to EP, and there may be other mechanisms that were not considered, which could result in a partial weakness of the mechanism analysis. Finally, municipal statistics may be more applicable to this topic than provincial statistics. While municipal data are more difficult to obtain, they can provide more sample information to portray causality in a more nuanced way. The threshold effect approach utilized in this study may not fully identify the joint effect of ER and ID on PHO.

Based on the above limitations, future research should be expanded in the following aspects: (1) City data or survey data with larger sample sizes should be further used to analyze the health effects of ER and ID. Due to the difficulty of obtaining public health data at the city level, cities within a region can be selected for the study, and individual public health indicators that are easily accessible can be chosen to reduce the difficulty of data collection. (2) A review of the literature on the economic effects of ER and ID is necessary to identify potential economic mechanisms and variables that affect health. This is beneficial for exploring the multidimensional pathways through which ER and ID promote the improvement of health levels. (3) Methods such as Differences-in-Differences and Panel Autoregressive models should be applied further to explore the causal relationships between ER and ID regarding health and to more reasonably reveal the significance of their combined effect on improving health levels. (4) The topic of this study has obvious interdisciplinary characteristics. Future research should endeavor to integrate theories from environmental science, medicine, and other disciplines, enhance multidisciplinary collaboration, and establish a comprehensive interdisciplinary research framework.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su16146156/s1>. Table S1: Results of descriptive statistics for variables. Table S2: Results of the robustness test.

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Nomenclature

Acronym	Full Name
PHO	Public health outcome
ER	Environmental regulation
CER	Command-based environmental regulation
MER	Market-based environmental regulation
VER	Voluntary environmental regulation
ID	Internet development
EW-T	Entropy weight–TOPSIS
SDM	Spatial Durbin model
SLM	Spatial lag model
SEM	Spatial error model
SWM	Spatial weight matrix

References

1. Brook, J.R.; Setton, E.M.; Seed, E.; Shooshtari, M.; Doiron, D.; Hlt, C.C.U.E. The Canadian urban environmental health research consortium—A protocol for building a national environmental exposure data platform for integrated analyses of urban form and health. *BMC Public Health* **2018**, *18*, 15. [[CrossRef](#)] [[PubMed](#)]
2. Jiang, Q.T.; Xu, Z.C.; Ye, G.Q.; Pahlow, M.; Hu, M.Z.; Qu, S. A systematic scoping review of environmental and socio-economic effects of COVID-19 on the global ocean-human system. *Sci. Total Environ.* **2022**, *849*, 157925. [[CrossRef](#)] [[PubMed](#)]
3. Orru, K.; Nordin, S.; Harzia, H.; Orru, H. The role of perceived air pollution and health risk perception in health symptoms and disease: A population-based study combined with modelled levels of pm10. *Int. Arch. Occup. Environ. Health* **2018**, *91*, 581–589. [[CrossRef](#)] [[PubMed](#)]
4. Deryugina, T.; Heutel, G.; Miller, N.H.; Molitor, D.; Reif, J. The mortality and medical costs of air pollution: Evidence from changes in wind direction. *Am. Econ. Rev.* **2019**, *109*, 4178–4219. [[CrossRef](#)] [[PubMed](#)]
5. Yang, T.; Zhou, K.L.; Ding, T. Air pollution impacts on public health: Evidence from 110 cities in Yangtze River economic belt of China. *Sci. Total Environ.* **2022**, *851*, 8. [[CrossRef](#)] [[PubMed](#)]
6. Peng, B.; Shen, X. Does Environmental regulation affect circular economy performance? Evidence from China. *Sustainability* **2024**, *16*, 4406. [[CrossRef](#)]
7. Cohen, A.J.; Brauer, M.; Burnett, R.; Anderson, H.R.; Frostad, J.; Estep, K.; Balakrishnan, K.; Brunekreef, B.; Dandona, L.; Dandona, R.; et al. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: An analysis of data from the global burden of diseases study 2015. *Lancet* **2017**, *389*, 1907–1918. [[CrossRef](#)]
8. Feng, D.L.; Hu, M.Z.; Zhao, L.D.; Liu, S. The impact of firm heterogeneity and external factor change on innovation: Evidence from the vehicle industry sector. *Sustainability* **2022**, *14*, 6507. [[CrossRef](#)]
9. He, X.; Chen, W. Digital transformation and environmental, social, and governance performance from a human capital perspective. *Sustainability* **2024**, *16*, 4737. [[CrossRef](#)]
10. Qiu, L.D.; Zhou, M.H.; Wei, X. Regulation, innovation, and firm selection: The porter hypothesis under monopolistic competition. *J. Environ. Econ. Manag.* **2018**, *92*, 638–658. [[CrossRef](#)]
11. Lazzini, S.; Occhipinti, Z.; Parenti, A.; Verona, R. Disentangling economic crisis effects from environmental regulation effects: Implications for sustainable development. *Bus. Strateg. Environ.* **2021**, *30*, 2332–2353. [[CrossRef](#)]
12. Li, F.; Lu, C.; Li, T. Air pollution, physical exercise, and physical health: An analysis based on data from the China general social survey. *Sustainability* **2024**, *16*, 4480. [[CrossRef](#)]
13. Tang, E.; Liu, F.C.; Zhang, J.J.; Yu, J. A model to analyze the environmental policy of resource reallocation and pollution control based on firms' heterogeneity. *Resour. Policy* **2014**, *39*, 88–91. [[CrossRef](#)]
14. Shapiro, J.S. Pollution trends and us environmental policy: Lessons from the past half century. *Rev. Environ. Econ. Policy* **2022**, *16*, 42–61. [[CrossRef](#)]
15. Cai, L.Z.; Guo, L. Environmental decentralization, environmental regulation and environmental pollution: Evidence from China. *Pol. J. Environ. Stud.* **2023**, *32*, 2053–2068. [[CrossRef](#)] [[PubMed](#)]
16. Kelly, F.J.; Fussell, J.C. Air pollution and public health: Emerging hazards and improved understanding of risk. *Environ. Geochem. Health* **2015**, *37*, 631–649. [[CrossRef](#)] [[PubMed](#)]
17. Pokharel, A.; Hennessy, D.A.; Wu, F.L.C. Health burden associated with tillage-related pm2.5 pollution in the United States, and mitigation strategies. *Sci. Total Environ.* **2023**, *903*, 10. [[CrossRef](#)] [[PubMed](#)]
18. Jing, Y.H.; Hu, M.Z.; Zhao, L.D. The effect of heterogeneous environmental regulations on the employment skill structure: The system-GMM approach and mediation model. *PLoS ONE* **2023**, *18*, e0290276. [[CrossRef](#)] [[PubMed](#)]
19. Peng, J.Y.; Xie, R.; Ma, C.B.; Fu, Y. Market-based environmental regulation and total factor productivity: Evidence from Chinese enterprises*. *Econ. Model* **2021**, *95*, 394–407. [[CrossRef](#)]
20. Nie, G.Q.; Zhu, Y.F.; Wu, W.P.; Xie, W.H.; Wu, K.X. Impact of voluntary environmental regulation on green technological innovation: Evidence from Chinese manufacturing enterprises. *Front. Energy Res.* **2022**, *10*, 13. [[CrossRef](#)]

21. Shen, N.; Liao, H.L.; Deng, R.M.; Wang, Q.W. Different types of environmental regulations and the heterogeneous influence on the environmental total factor productivity: Empirical analysis of China's industry. *J. Clean. Prod.* **2019**, *211*, 171–184. [\[CrossRef\]](#)
22. Yu, X.; Wang, P. Economic effects analysis of environmental regulation policy in the process of industrial structure upgrading: Evidence from Chinese provincial panel data. *Sci. Total Environ.* **2021**, *753*, 10. [\[CrossRef\]](#) [\[PubMed\]](#)
23. Denfanapapol, S.; Setthasuravich, P.; Rattanakul, S.; Pukdeewut, A.; Kato, H. The digital divide, wealth, and inequality: An examination of socio-economic determinants of collaborative environmental governance in Thailand through provincial-level panel data analysis. *Sustainability* **2024**, *16*, 4658. [\[CrossRef\]](#)
24. Yin, X.C.; Li, J.; Si, H.Y.; Wu, P. Attention marketing in fragmented entertainment: How advertising embedding influences purchase decision in short-form video apps. *J. Retail. Consum. Serv.* **2024**, *76*, 103572. [\[CrossRef\]](#)
25. Martin, N.; Rice, J. Rebalancing climate change debate and policy: An analysis of online discussions. *Environ. Policy Gov.* **2014**, *24*, 338–350. [\[CrossRef\]](#)
26. Takahashi, Y.; Ohura, T.; Ishizaki, T.; Okamoto, S.; Miki, K.; Naito, M.; Akamatsu, R.; Sugimori, H.; Yoshiike, N.; Miyaki, K.; et al. Internet use for health-related information via personal computers and cell phones in Japan: A cross-sectional population-based survey. *J. Med. Internet Res.* **2011**, *13*, 14. [\[CrossRef\]](#) [\[PubMed\]](#)
27. Lyu, S.J.; Sun, J. Internet use and self-rated health among Chinese older adults: The mediating role of social capital. *Geriatr. Gerontol. Int.* **2021**, *21*, 34–38. [\[CrossRef\]](#) [\[PubMed\]](#)
28. Wu, H.T.; Ba, N.; Ren, S.Y.; Xu, L.; Chai, J.X.; Irfan, M.; Hao, Y.; Lu, Z.N. The impact of internet development on the health of Chinese residents: Transmission mechanisms and empirical tests. *Socio-Econ. Plan. Sci.* **2022**, *81*, 15. [\[CrossRef\]](#)
29. Garrett, B.; Mallia, E.; Anthony, J. Public perceptions of internet-based health scams, and factors that promote engagement with them. *Health Soc. Care Community* **2019**, *27*, E672–E686. [\[CrossRef\]](#)
30. Hatcher, W.; Hunter, L.; Meares, W.; Lizotte, M.K.; Avent-Holt, D. Community-level internet connectivity and mental health: An analysis of united states counties. *J. Ment. Health* **2019**, *28*, 490–494. [\[CrossRef\]](#)
31. Alsamrai, O.; Redel-Macias, M.D.; Pinzi, S.; Dorado, M.P. A systematic review for indoor and outdoor air pollution monitoring systems based on Internet of Things. *Sustainability* **2024**, *16*, 4353. [\[CrossRef\]](#)
32. Dutta, U.P.; Gupta, H.; Sengupta, P.P. ICT and health outcome nexus in 30 selected Asian countries: Fresh evidence from panel data analysis. *Technol. Soc.* **2019**, *59*, 101184. [\[CrossRef\]](#)
33. Omri, A.; Kahouli, B.; Kahia, M. Environmental sustainability and health outcomes: Do ICT diffusion and technological innovation matter? *Int. Rev. Econ. Financ.* **2024**, *89*, 1–11. [\[CrossRef\]](#)
34. Chou, W.Y.S.; Liu, B.M.; Post, S.; Hesse, B. Health-related internet use among cancer survivors: Data from the health information national trends survey, 2003–2008. *J. Cancer Surviv.-Res. Pract.* **2011**, *5*, 263–270. [\[CrossRef\]](#)
35. Zhang, J.P.; Gong, X.M.; Zhang, H. ICT diffusion and health outcome: Effects and transmission channels. *Telemat. Inform.* **2022**, *67*, 101755. [\[CrossRef\]](#)
36. Gong, X.; Zhang, H.; Zhang, J. Digital wallet, happy heart: An analysis based on the economic–social–environmental perspective. *J. Theor. Appl. Electron. Commer. Res.* **2024**, *19*, 1222–1242. [\[CrossRef\]](#)
37. Sinclair, A.J.; Peirson-Smith, T.J.; Boerchers, M. Environmental assessments in the internet age: The role of e-governance and social media in creating platforms for meaningful participation. *Impact Assess. Proj. Apprais.* **2017**, *35*, 148–157. [\[CrossRef\]](#)
38. He, Q.; Deng, X.; Li, C.; Yan, Z.C.; Qi, Y.B. Do internet skills increase farmers' willingness to participate in environmental governance? Evidence from rural China. *Agriculture* **2021**, *11*, 1202. [\[CrossRef\]](#)
39. Zhang, D.; Sana, U. Towards a green economy in China? Examining the impact of the internet of things and environmental regulation on green growth. *Sustainability* **2023**, *15*, 2528. [\[CrossRef\]](#)
40. Grossman, M. On the concept of health capital and the demand for health. *J. Polit. Econ.* **1972**, *82*, 233–255. [\[CrossRef\]](#)
41. Cropper, M.L. Measuring the benefits from reduced morbidity. *Am. Econ. Rev.* **1981**, *71*, 235–240. [\[PubMed\]](#)
42. Fan, H.C.; Lin, F.Q.; Lin, S. The hidden cost of trade liberalization: Input tariff shocks and worker health in China. *J. Int. Econ.* **2020**, *126*, 24. [\[CrossRef\]](#)
43. Xie, Q.; Feng, J. The health and welfares of environmental regulation. *China Econ. Q.* **2023**, *23*, 894–912. [\[CrossRef\]](#)
44. Ye, W.Q.; Huang, Z.J. The long-term effect of air pollution on health outcomes for the middle-aged and the elderly. *J. Huazhong. Univ. Sci. Technol.-Soc. Sci. Ed.* **2022**, *36*, 121–135. [\[CrossRef\]](#)
45. Yang, X.D.; Wu, H.T.; Ren, S.Y.; Ran, Q.Y.; Zhang, J.N. Does the development of the internet contribute to air pollution control in China? Mechanism discussion and empirical test. *Struct. Change Econ. Dyn.* **2021**, *56*, 207–224. [\[CrossRef\]](#)
46. Li, M.J.; Du, W.J. Can internet development improve the energy efficiency of firms: Empirical evidence from China. *Energy* **2021**, *237*, 9. [\[CrossRef\]](#)
47. Gu, F.; Zhang, W.J.; Guo, J.F.; Hall, P. Exploring “internet plus recycling”: Mass balance and life cycle assessment of a waste management system associated with a mobile application. *Sci. Total Environ.* **2019**, *649*, 172–185. [\[CrossRef\]](#) [\[PubMed\]](#)
48. Hu, M.Z. Multivariate understanding of income and expenditure in united states households with statistical learning. *Comput. Stat.* **2022**, *37*, 2129–2160. [\[CrossRef\]](#)
49. Feng, Y.C.; Wang, X.H.; Du, W.C.; Wu, H.Y.; Wang, J.T. Effects of environmental regulation and FDI on urban innovation in China: A spatial Durbin econometric analysis. *J. Clean. Prod.* **2019**, *235*, 210–224. [\[CrossRef\]](#)
50. Hansen, B.E. Threshold effects in non-dynamic panels: Estimation, testing, and inference. *J. Econom.* **1999**, *93*, 345–368. [\[CrossRef\]](#)

51. Ahmad, N.A.; Ismail, N.W.; Sidique, S.F.A.; Mazlan, N.S. Air pollution, governance quality, and health outcomes: Evidence from developing countries. *Environ. Sci. Pollut. Res.* **2023**, *30*, 41060–41072. [\[CrossRef\]](#) [\[PubMed\]](#)
52. Constant, K.; Davin, M. Pollution, children’s health and the evolution of human capital inequality. *Math. Soc. Sci.* **2021**, *112*, 9–25. [\[CrossRef\]](#)
53. Sanders, B.; Davis, M. Effects of climate change and air pollution on perinatal health. *J. Midwifery Women Health* **2023**, *68*, 383–390. [\[CrossRef\]](#) [\[PubMed\]](#)
54. Chen, H.; Li, L.; Lei, Y.L.; Wu, S.M.; Yan, D.; Dong, Z.Y. Public health effect and its economics loss of PM2.5 pollution from coal consumption in China. *Sci. Total Environ.* **2020**, *732*, 8. [\[CrossRef\]](#)
55. Hu, M.; Zhang, Y.; Dowling, N.M. An analysis of factors predicting memory loss in Alzheimer’s disease prevention. In Proceedings of the 2017 International Joint Conference on Neural Networks (IJCNN), Anchorage, AK, USA, 14–19 May 2017. [\[CrossRef\]](#)
56. Zhang, K.K.; Xu, D.Y.; Li, S.R. The impact of environmental regulation on environmental pollution in China: An empirical study based on the synergistic effect of industrial agglomeration. *Environ. Sci. Pollut. Res.* **2019**, *26*, 25775–25788. [\[CrossRef\]](#) [\[PubMed\]](#)
57. Li, Y.; Hu, M.Z.; Zhao, L.D. Study on the impact of industrial green development and technological innovation on employment structure. *Front. Earth Sci.* **2023**, *11*, 1115476. [\[CrossRef\]](#)
58. Li, R.; Sun, T. Research on impact of different environmental regulation tools on energy efficiency in China. *Pol. J. Environ. Stud.* **2020**, *29*, 4151–4160. [\[CrossRef\]](#)
59. Zhao, K.; Wu, C.; Liu, J.; Liu, Y. Green finance, green technology innovation and the upgrading of China’s industrial structure: A study from the perspective of heterogeneous environmental regulation. *Sustainability* **2024**, *16*, 4330. [\[CrossRef\]](#)
60. Yang, T.R.; Liu, W.L. Does air pollution affect public health and health inequality? Empirical evidence from China. *J. Clean. Prod.* **2018**, *203*, 43–52. [\[CrossRef\]](#)
61. Shen, W.T.; Yu, X.; Zhong, S.B.; Ge, H.R. Population health effects of air pollution: Fresh evidence from China health and retirement longitudinal survey. *Front. Public Health* **2021**, *9*, 12. [\[CrossRef\]](#)
62. Pei, Y.H.; Chen, H.L.; Liu, Z.H.; Hu, H.Z. Does environmental regulation improve residents’ health? Evidence from China. *Front. Public Health.* **2023**, *11*, 11. [\[CrossRef\]](#)
63. Hou, B.; Li, Y.M.; Wang, H.X. Internet use and health status among older adults: The mediating role of social participation. *Front. Public Health* **2022**, *10*, 11. [\[CrossRef\]](#)
64. Anser, M.K.; Hanif, I.; Vo, X.V.; Alharthi, M. The long-run and short-run influence of environmental pollution, energy consumption, and economic activities on health quality in emerging countries. *Environ. Sci. Pollut. Res.* **2020**, *27*, 32518–32532. [\[CrossRef\]](#) [\[PubMed\]](#)
65. Pu, L.D. Fairness of the distribution of public medical and health resources. *Front. Public Health* **2021**, *9*, 14. [\[CrossRef\]](#)
66. Han, Y.; Zhu, Y.J. Study on the effect of supercritical CFB boiler air preheater and flue gas treatment facilities on sulfur trioxide emission characteristics. *Energy Rep.* **2022**, *8*, 926–939. [\[CrossRef\]](#)
67. Zhao, Z.B.; Shi, X.P.; Cao, Y.; Hu, M.Z. The impact of urban population spatial distribution on CO₂ emissions in China from the perspective of individual and interactive effects. *Environ. Sci. Pollut. Res.* **2023**, *30*, 117096–117109. [\[CrossRef\]](#)
68. Wu, F.; Chen, W.; Lin, L.L.; Ren, X.; Qu, Y.N. The balanced allocation of medical and health resources in urban areas of China from the perspective of sustainable development: A case study of Nanjing. *Sustainability* **2022**, *14*, 6707. [\[CrossRef\]](#)
69. Lesage, J.; Pace, R.K. *Introduction to Spatial Econometrics*; CRC Press: Boca Raton, FL, USA, 2009.
70. Qu, X.; Lee, L.F. Estimating a spatial autoregressive model with an endogenous spatial weight matrix. *J. Econom.* **2015**, *184*, 209–232. [\[CrossRef\]](#)
71. Qu, X.; Lee, L.F.; Yu, J.H. QML estimation of spatial dynamic panel data models with endogenous time varying spatial weights matrices. *J. Econom.* **2017**, *197*, 173–201. [\[CrossRef\]](#)
72. Sun, J.; Zhai, N.N.; Miao, J.C.; Mu, H.R.; Li, W.X. How do heterogeneous environmental regulations affect the sustainable development of marine green economy? Empirical evidence from China’s coastal areas. *Ocean Coastal Manag.* **2023**, *232*, 10. [\[CrossRef\]](#)

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