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Original Research

Impact of Environmental Regulation on Residents' Life Satisfaction: Based on the Subjective Cognitive Perspective of the Residents

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Abstract

The implementation of environmental regulation holds positive significance for the improvement of the ecological environment and social well-being. In order to explore the impact of environmental regulation on residents' life satisfaction, an empirical analysis was conducted using data from the China Family Panel Studies (CFPS-2020), focusing on a sample of 13,669 respondents across 25 provinces in China. The mediation effect model was also used to investigate the influence mechanism from the residents' subjective cognitive perspective. The results indicate that: (1) Environmental regulation has a significant effect on residents' life satisfaction, as confirmed by various robustness tests. (2) The effect of environmental regulation on improving residents' life satisfaction is more pronounced among urban residents, young people, and those with a college education or higher. (3) Environmental regulation improves residents' life satisfaction by minimizing their pollution perception and enhancing their self-rated health. Based on these findings, the government needs to continuously strengthen the supervision of environmental regulations, enhance residents' trust in environmental policies, and formulate more accurate environmental improvement measures for different groups of residents simultaneously.

Keywords: environmental regulation, residents' life satisfaction, subjective cognition, pollution perception, self-rated health

Introduction

With the rapid economic development and continuous social progress, the material living standards of Chinese people have significantly improved. However, the rough economic growth model adopted by China in the past has led to excessive emissions of industrial pollutants [1], inflicting profound harm upon people's living environment. In recent years, environmental challenges, notably air and water pollution, have emerged as increasingly pressing issues, with environmental pollution gradually becoming a pivotal constraint on sustainable development. Environmental pollution not only causes damage to the ecosystem but also directly or indirectly affects the daily work and life of residents [2], making it difficult for people to pursue a better living environment. Recognizing this, environmental regulation has been introduced as a key strategy to address these challenges. By raising pollution emission standards and promoting cleaner production

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technologies, environmental regulation aims to improve the quality of the living environment [3]. This direct improvement in environmental quality has a positive significance for enhancing the residents' life satisfaction [4]. Against this backdrop, as an important means for the government to address environmental pollution issues, investigating the impact of environmental regulation on the residents' life satisfaction is of particular importance. This analysis is crucial for ensuring that environmental policies are effectively designed and implemented to meet the needs and aspirations of the public.

The impact of environmental regulation on economic, social, and environmental development remains a focal point of scholarly and societal interest, with early studies mainly concentrated on its economic effects [5]. For example, environmental regulation can force enterprises to reform environmental management and production technology, so as to promote the transformation and upgrading of industrial structure, and ultimately contribute to the realization of sustainable economic development [6]. Although some studies have explored the relationship between environmental quality and residents' happiness, most of them start from the perspective of objective environmental pollution, and there are relatively few studies on the impact of environmental regulation on residents' subjective well-being. For instance, some research has explored the direct impact of environmental pollution on residents' physical health, indicating that air pollution can lead to chronic respiratory illnesses and related problems [7]. However, few studies have discussed the impact of environmental regulation on residents' happiness or life satisfaction from the perspective of residents' subjective cognition.

In summary, most studies have explored the impact of environmental regulation on economic development and environmental pollution, as well as the impact of objective environmental conditions on residents' physical and mental health. However, few studies have examined whether environmental regulations significantly improve environmental conditions from the perspective of residents' subjective environmental cognition, and how such environmental cognition translates into the improvement of residents' life satisfaction. Therefore, this study will provide a new perspective and evidence for understanding how environmental regulation enhances residents' life satisfaction by affecting their subjective cognition. The main research contents and possible contributions of this study are as follows: (1) Based on the matching of the China Family Panel Studies (CFPS-2020) data and the officially announced provincial macro-environmental data, this paper constructs a regression model with a sample of 13669 respondents to empirically analyze the impact of environmental regulations on residents' life satisfaction. (2) The mediation effect model is adopted to explore the impact of environmental regulation on residents' life satisfaction by influencing their pollution perception and self-rated health. (3) The differing responses of various resident groups (such as those in urban and rural areas, different age groups, and education levels) to the impact of environmental regulation are analyzed, providing a basis for formulating more targeted environmental improvement measures. By deeply analyzing the effects and mechanisms of environmental regulation, this paper not only enriches the research content of environmental economics and welfare economics but also provides valuable policy implications for the government in formulating and implementing environmental policies.

Literature Review

Environmental Regulation

Environmental regulation, as an important measure for governments or relevant institutions to standardize and constrain environmental pollution behaviors in economic activities through the formulation of laws, regulations, and policy standards, has always been a hot topic in the fields of economics, environmental science, and policy research. According to the literature collected, most studies focus on the environmental and socio-economic effects of environmental regulation. The traditional view is that an increase in the intensity of environmental regulation in the short term will increase the pollution control costs of enterprises, thereby reducing corporate profits and market competitiveness. However, the "Porter Hypothesis" challenges this traditional view, arguing that appropriate environmental regulation can achieve a "win-win" situation for environmental protection and economic growth [8]. Other studies believe that environmental regulation will show a phased characteristic in economic development [9]. From the perspective of the environmental effects, a large number of studies have shown that environmental regulation can inhibit corporate pollution emissions, with the obvious effect of forcing emission reductions [10]. However, some scholars argue that the emission reduction effects of environmental regulation are not as significant as they might appear. For example, research has indicated that while policies like the "Three Rivers and Three Lakes" initiative have forced many small polluting enterprises out of the market, they have not had a substantial impact on the chemical oxygen demand emissions of the enterprises that remain [11].

Residents' Life Satisfaction

Residents' life satisfaction is a multidimensional concept that has been widely applied in the analysis of microeconomic phenomena and the valuation of non-market goods, yielding a rich array of research outcomes [12, 13]. Early studies primarily focused on exploring the impact of economic factors such as economic growth, absolute income, and income disparity on residents' life satisfaction [14]. Subsequently, building upon the foundation of sociological research, scholars examined

the relationship between demographic factors, such as age, marital status, health conditions, educational levels, and psychological factors, with residents' life satisfaction [15]. As research has continued to expand and delve deeper, non-economic factors such as the prevalence of regional infrastructure, environmental quality, and social shock events have become key subjects of investigation [16, 17]. As people increasingly pay attention to environmental issues, the quality of the ecological environment, as an essential component of residents' lives, has been extensively and profoundly explored by numerous scholars. Many studies indicate that environmental pollution directly impacts the physical and mental health of residents [18, 19]. Moreover, it can also affect people's social interactions and leisure activities. For instance, studies have shown that an increase in PM2.5 levels can lead to a reduction in the time Chinese residents spend on outdoor leisure and physical activities related to transportation [20]. That is to say, environmental pollution can significantly reduce residents' life satisfaction or sense of well-being.

The Relationship between the Above Two

Currently, there is a scarcity of research that directly examines the impact of environmental regulation on residents' life satisfaction or happiness. The majority of scholars have focused on the perspective of environmental quality, noting that environmental pollution leads to a decrease in residents' life satisfaction. Only a few studies have considered environmental regulation as a moderation mechanism between environmental conditions and residents' life satisfaction [21, 22]. Environmental regulation refers to a series of economic, legal, or administrative measures taken by governments to reduce environmental pollution, conserve natural resources, and promote sustainable development [3, 23], thereby positively influencing the improvement of ecological environment quality and residents' life satisfaction. Firstly, environmental regulation can reduce pollutant emissions through measures such as air quality control, water quality protection, and waste management [24], thereby creating a more comfortable and secure living environment for residents, which can effectively reduce the increased risk of illness caused by the discharge of pollutants [25, 26]. Additionally, good environmental quality contributes to enhancing the mental health of residents [27], which in turn improves their life satisfaction. Together, these aspects help elevate the overall life satisfaction of residents.

In summary, despite the extensive analysis of environmental regulation and residents' life satisfaction conducted by existing studies, there are still some research gaps. On one hand, most studies focus on the economic and environmental impacts of environmental regulation, with fewer directly exploring its effects on residents' life satisfaction or happiness. Only a few studies have considered environmental regulation as a moderating mechanism between environmental conditions and residents' life satisfaction. On the other hand, the multidimensional analysis of residents' subjective cognition in related studies is insufficient, and there is a lack of in-depth analysis on how the subjective cognition of environmental regulation specifically impacts residents' life satisfaction, particularly in comparative studies across different cultural and economic backgrounds. Therefore, this paper will investigate the direct impact of environmental regulation on residents' life satisfaction, and provide a new perspective for understanding how environmental regulation affects residents' life satisfaction by focusing on residents' subjective cognition. This is of significant theoretical and practical importance for the formulation and implementation of environmental policies.

Theoretical Analysis and Research Hypotheses

The Mediation Role of Residents' Subjective Cognition

Existing research indicates that the impact of environmental quality on residents' life satisfaction is primarily reflected in two aspects: objective environmental pollution and subjective environmental cognition. Subjective environmental cognition refers to residents' subjective awareness of their surroundings, including evaluations of the environment's aesthetics, livability, and sense of safety [28]. This cognition differs from objective environmental pollution as it is influenced by individual factors such as income level, health status, and the extent of knowledge about the environment. The existing literature has conducted some research on residents' subjective environmental preferences, and it is generally believed that subjective environmental cognition significantly affects residents' life satisfaction, potentially to a greater extent than objective environmental conditions [29, 30]. From this, it can be inferred that residents' subjective cognition can serve as a mediation mechanism for the impact of environmental regulations on residents' life satisfaction.

On one hand, environmental regulation has a positive impact on residents' life satisfaction by mitigating their pollution perception, which is mainly due to the combined effects of improved environmental quality, government actions, and social benefits. Firstly, the implementation of environmental regulation significantly curtails the sources of environmental pollution. As these sources diminish, so does the residents' exposure to pollutants, thereby lessening their awareness of environmental contamination. When individuals perceive their surroundings as cleaner, safer, and more congenial, their life satisfaction naturally escalates [31]. Subsequently, the implementation of environmental regulation also signifies the government's attention and action towards environmental protection [32]. This enhances residents' trust and satisfaction in the government, reinforcing

their expectations for environmental improvements and fostering a positive outlook on the future. When residents perceive that the government has taken measures to improve environmental quality, their evaluation of the government tends to be more positive, which in turn enhances their life satisfaction. Furthermore, the enforcement of environmental regulation may also lead to changes in social consensus and cultural atmosphere, promoting residents' sense of social identity and belonging. Upon recognizing that the environmental quality has improved as a consequence of regulatory measures, residents may exhibit a greater propensity to engage in environmental conservation efforts [33], and this sense of social participation and achievement will also contribute to an increase in life satisfaction.

On the other hand, environmental regulation exerts a positive impact on life satisfaction by improving residents' self-rated health levels, reflecting the pivotal role of environmental protection in improving individual health and quality of life. Firstly, the implementation of environmental regulation ameliorates the living environment for residents. By diminishing pollution sources and enhancing the quality of air and water, these measures decrease the likelihood of residents' exposure to harmful substances, thereby reducing the incidence of illness and health-related issues. When residents perceive improvements in their surroundings, their self-assessment of health tends to be more positive [34], and this enhancement in self-evaluation is closely related to life satisfaction. Secondly, the implementation of environmental regulation fosters a heightened awareness of health. As environmental issues increasingly attract attention, people have a deeper understanding and recognition of the relationship between environmental pollution and health [35]. Consequently, residents pay more attention to health protection and adopt more healthful behaviors and lifestyles, which further improves their self-rated health levels. In addition, environmental regulation can also have a salutary effect on residents' mental health. An improved environmental quality, coupled with heightened health consciousness, can alleviate stress and anxiety, thereby enhancing psychological well-being [36]. When residents experience the positive effects of environmental regulation, their mental state becomes more peaceful and positive, leading to a corresponding rise in life satisfaction.

The Moderation Role of Individual Characteristics

Diverse demographic groups, characterized by variations in age, urban or rural residence, and educational attainment, exhibit significant differences in their cognition and receptiveness to environmental regulation. These disparities can profoundly shape their attitudes toward environmental policies and consequently influence their assessments of life satisfaction.

Different age groups possess distinct perceptions and responses to environmental regulation, which are influenced by factors such as group characteristics, psychological cognition, and life experiences. Young individuals, who are usually at the beginning stage of life, place more emphasis on future sustainable development and environmental protection [37]. They are more inclined to support environmentally friendly policies and respond more positively to environmental regulation. In contrast, the elderly, who have typically established more stable lifestyles, may focus more on immediate, practical concerns in daily life, exhibiting less sensitivity to the implications of environmental regulation. Additionally, environmental regulation may impose additional economic burdens, such as higher energy costs, more expensive eco-friendly products, and potentially even a slowdown in economic growth [38, 39]. While younger individuals may exhibit less sensitivity to fluctuations in pricing, middle-aged and older demographics are more likely to be concerned about economic costs, which could offset their cognition of the potential benefits of environmental regulation.

The responses of urban and rural residents to environmental regulation also differ, involving factors such as regional environment, economic development, and social structure. Urban areas are more affected by industry, transportation, and other factors, resulting in relatively higher levels of environmental pollution, and the enforcement of environmental regulation may also be more stringent and apparent, leading to more direct benefits for urban residents from reduced industrial pollution and improved public spaces. In contrast, rural regions typically boast more pristine natural settings and are less impacted by pollution, often experiencing less stringent regulatory enforcement [40]. As a result, the tangible effects of environmental regulation may be less pronounced for rural residents. Furthermore, urban areas have developed media, making it easier for environmental issues and regulatory achievements to be disseminated through news and social networks, enhancing urban residents' perception of environmental improvement [41]. In rural areas, due to limited channels for information dissemination, residents may not be well-informed about the specific content and effectiveness of environmental regulation.

Educational attainment significantly influences individuals' cognition, participation, and information acquisition regarding environmental regulation, which in turn determines different groups' responses to and benefits from environmental regulations. Individuals with higher levels of education typically have a systematic education, broader knowledge, and a better understanding of the potential impacts of environmental pollution on health and life [33]. As a result, they are more willing to support and participate in environmental regulation measures and are more capable of adopting environmentally friendly behaviors, thus benefiting more from the improved environment [42]. Additionally, individuals with advanced education typically enjoy

higher economic income and social status, coupled with greater aspirations and expectations for quality of life. Environmental regulation, by enhancing environmental quality, may more directly meet the needs of this group for a healthy and comfortable living environment. In contrast, individuals with lower levels of education may have a lower awareness of environmental protection and an insufficient understanding of the importance of environmental regulation. Moreover, environmental regulation may potentially exert adverse effects on the employment prospects of those with lesser education, with studies suggesting that environmental regulation could lead to unemployment among certain low-skilled workers [43]. This economic pressure may offset the improvements in quality of life brought about by environmental regulation.

Based on the above discussion, this paper proposes the following research hypotheses:

Hypothesis 1: Environmental regulation has a positive impact on residents' life satisfaction by reducing their pollution perception and improving their self-rated health.

Hypothesis 2: The impact of environmental regulation on residents' life satisfaction is moderated by different group characteristics.

Research Design

Empirical Model

In order to assess the impact of environmental regulation on residents' life satisfaction, this paper constructs the following multiple linear regression model:

$$Satisfaction_i = \alpha_0 + \alpha_1 Environment_p + \beta_1 Individual_{i,p} + \beta_2 Regional_p + \delta_{i,p}$$

Where the subscripts i and p represent individuals and provinces, respectively. $Satisfaction_i$ is the dependent variable of this paper, $Environment_p$ is the core explanatory variable. $Individual_{i,p}$ and $Regional_p$ represent the control variable, the former represents a series of micro individual characteristics of the i interviewee in the p province, the latter represents a series of macroeconomic variables in the p province, and $\delta_{i,p}$ is the error term. In this model, the magnitude and direction of the regression coefficient α_1 is the main concern of the paper.

In addition, in order to explore the mechanism of environmental regulation affecting residents' life satisfaction, based on reference to relevant literature [44], this paper adopts the method of step-by-step regression to build the following model:

$$M_i = \alpha_0 + \alpha_1 Environment_p + \beta_1 Individual_{i,p} + \beta_2 Regional_p + \delta_{i,p}$$

$$Satisfaction_i = \alpha_0 + \alpha_1 Environment_p + \alpha_2 M_i + \beta_1 Individual_{i,p} + \beta_2 Regional_p + \delta_{i,p}$$

Among them, M_i is a mediation variable, which mainly includes pollution perception and self-rated health. Based on the above benchmark regression steps, the first step is to observe whether environmental regulations impact the intermediary variables, and then all the core explanatory variables and mediation variables are added to the model. When the regression coefficient α_1 and α_2 are significant, it can be considered that the mediation variables play a role in the transmission mechanism.

Variable Measurement

Dependent Variable

Residents' life satisfaction constitutes the principal focus of this study, mirroring residents' subjective assessment of their own quality of life and serving as a comprehensive measurement based on the comparison between ideal and actual circumstances. The majority of scholars utilize self-reports of respondents as an indicator of life satisfaction [12, 45], and such methodology is adopted in this research. In the CFPS-2020 survey, life satisfaction is evaluated using a five-point Likert scale, where respondents were asked "How satisfied are you with your life?" This question is answered on a response scale ranging from 1 to 5, with 1 denoting "very dissatisfied" and 5 signifying "very satisfied". As the score assigned by respondents increases, so does their level of life satisfaction.

Core Explanatory Variable

The intensity of environmental regulation is the core explanatory variable in this study, reflecting the policy strength of the government in environmental protection. There is no unified index for environmental regulation in academia. Typically, environmental regulation can be measured from three aspects: the intensity of environmental pollution control investment, the effectiveness of environmental management, and the attention to environmental issues by local governments. In terms of the intensity of environmental pollution control investment, existing literature uses the "proportion of pollution control costs to industrial output value" or the "proportion of pollution control investment to GDP" to estimate the intensity of environmental regulation [46]. Regarding the effectiveness of environmental management, most studies construct a comprehensive environmental regulation index based on multiple individual indicators such as sulfur dioxide emissions, wastewater discharge, and solid waste discharge [47]. In terms of the attention to environmental issues by local governments, some literature measures this based on the implementation of

environmental protection regulations and the frequency of environmental-related terms in government work reports [48, 49]. Given the data availability and the fact that pollution control investment largely represents the local government's determination and attitude towards controlling pollution, this study uses the "proportion of pollution control investment to GDP" to measure the intensity of environmental regulation, with a higher ratio indicating stronger environmental regulation.

Control Variables

In order to control other factors that may affect residents' life satisfaction and make the estimation results more accurate, this paper added several control variables to the model based on reference to relevant literature [14-16]. These include a series of micro-level individual characteristics such as gender, marital status, job satisfaction, chronic disease conditions, medical treatment levels, and siesta habits, as well as a series of macroeconomic variables such as per capita GDP, consumer price index, public transport vehicle ownership per 10,000 people, per capita park green space area, hospital bed density per 10,000 people, and public library collection volume per person. A series of micro variables such as gender and marital status reflect an individual's family support and social support network, which in turn affect their life satisfaction. Macro indicators such as per capita GDP and park area mirror regional economic development level and infrastructure construction; these variables also exert a significant influence on individual life satisfaction.

Mediation Variables

Based on the above analysis, environmental regulation affects residents' subjective cognition. Given the availability of data, this study selects residents' pollution perception and self-rated health as mediating variables. Pollution perception is measured using the questionnaire response to "How serious do you think the local environmental pollution problem is?" The response scale ranges from 0 to 10, where 0 represents "not serious" and 10 represents "very serious". Self-rated health is measured using the questionnaire response to "How do you rate your current health status?" The response scale ranges from 1 to 5, where 1 represents "unhealthy" and 5 represents "very healthy". Residents' perception of local environmental pollution is their direct feedback to the effect of environmental regulation, and self-rated health, as a subjective health assessment of residents, is also affected by objective environmental conditions, so these two indicators are selected as mediation variables.

Data Source

This study uses the China Family Panel Studies (CFPS-2020) data conducted by Peking University for empirical analysis. As a national social tracking survey, CFPS covers 25 provinces in China, representing 95% of the total national population, with good sample representativeness. CFPS employs a stratified multi-stage sampling method to track and collect data at different levels (including individuals, families, and communities), deeply reflecting the changes in China's socio-economic conditions, family structure, and population health. The survey is conducted every two years, and the latest publicly released data is from the year 2020. The CFPS-2020 survey collected a total of 27,646 valid resident questionnaires. For this study, which examines the impact of environmental regulation on residents' life satisfaction, samples of residents aged 18 and above were selected, and samples with missing or unusable key information were excluded. In the end, a total of 13,669 complete survey samples were included in the regression model of this study. In addition, this study matches the CFPS data with the corresponding macro provincial data, sourced from the "China Statistical Yearbook" and the "China Environmental Statistical Yearbook." The descriptive statistics for the relevant variables are shown in Table 1.

Results and Discussion

Baseline Regression

The processed data were introduced into the regression model using Stata 15.0 software to investigate the influence of the selected indicators on residents' life satisfaction. As per the regression results presented in Table 2, Model (1), the regression coefficient for the intensity of environmental regulation is positive and is significant at the 5% level. This suggests that an increase in the intensity of environmental regulation indeed significantly enhances the life satisfaction of residents. To further validate the robustness of this finding, individual and regional control variables were incorporated into Models (2). The inclusion of these control variables helps mitigate the influence of other factors that may affect residents' life satisfaction, thus providing a more precise estimation of the impact of environmental regulation. The R-squared (R^2) values in Table 2 indicate an incremental improvement in the model's explanatory power with the addition of control variables. Ultimately, even after accounting for all individual and regional variables, the coefficient for the intensity of environmental regulation remains significantly positive at the 5% level, confirming the significant positive effect of environmental regulation on residents' life satisfaction.

Robustness Checks

The robustness checks aim to ensure that the study's findings are not a result of model specification idiosyncrasies or specific sample selection biases. To

Table 1. Descriptive statistics for each variable.

Variable	Definition	Mean	Std. Dev.	Min	Max
Satisfaction	Residents' life satisfaction (1=very dissatisfied, 5=very satisfied)	4.01	0.93	1	5
Environment	Environmental regulation (pollution control investment / GDP)	4.57	3.22	0.14	15.97
Gender	Gender (male =1, female =0)	0.50	0.50	0	1
Marriage	Marital status (Married =1, other =0)	0.86	0.34	0	1
Job	Job satisfaction (1=very dissatisfied, 5=very satisfied)	3.69	0.95	1	5
Disease	Chronic disease (yes=1,no =0)	0.14	0.35	0	1
Treatment	Level of medical treatment (1=bad, 5=good)	3.62	0.91	1	5
Siesta	Siesta(Yes =1, no =0)	0.59	0.49	0	1
GDP	Per capita GDP (Yuan)	6.37	2.82	3.58	16.42
CPI	Consumer price index of food category (last year =100)	110.29	2.21	105.40	115.80
Bus	Public transport vehicles per 10,000 people (Taiwan)	12.65	1.71	8.30	17.25
Park	Green park area per capita (square meters)	14.53	2.04	9.05	21.02
Bed	Beds per 10,000 people (one)	65.61	8.39	44.80	79.50
Book	Public library collection per person (volume)	0.82	0.58	0.41	3.25
Pollution	Pollution perception (0=not serious, 10=very serious)	6.32	2.84	0	10
Health	Self-rated health (1=unhealthy, 5=very healthy)	3.08	1.19	1	5
Age	Age(year)	46.30	13.80	18	86
Urban	Urban and rural areas (Urban=1,rural =0)	0.47	0.50	0	1
Education	Education (1=No learning experience, 9=PhD)	3.88	1.40	1	9

Table 2. Benchmark regression and robustness test results.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Ols	Ols	Ologit	Oprobit	Replace	Delete	Iv
Environment	0.005369*	0.005743*	0.012499*	0.007005*	0.046954**	0.005526*	0.092284***
	(2.17)	(2.42)	(2.47)	(2.34)	(3.13)	(2.27)	(3.61)
Cons	3.981918***	1.344637**	-	-	1.449321**	1.506853**	-1.236486
	(287.95)	(2.58)			(2.81)	(2.59)	(-1.30)
Controlled variable	NO	YES	YES	YES	YES	YES	YES
N	13669	13669	13669	13669	13669	13357	13669
R^2	0.0003	0.1191	0.0521	0.0509	0.119	0.1189	0.0333

Note: *t* statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The same below.

this end, the study employs several methods to verify the robustness of the baseline regression results.

Considering that the dependent variable in this study is an ordinal categorical variable ranging from 1 to 5, the study utilizes both the Ordered Logit and Ordered Probit models for regression analysis, thereby reducing the estimation errors associated with the Ordinary Least Squares (OLS) method. The results in Table 2, Models (3) and (4), demonstrate that regardless of the regression method used, the coefficient for environmental regulation remains significantly positive at the 5% level, aligning with the baseline regression outcomes.

Subsequently, the study examines the robustness of the results by substituting the core explanatory

Table 3. Heterogeneity Analysis Results.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Age<45	Age≥45	Urban	Rural	Edu<5	Edu≥5
Environment	0.008275*	0.003701	0.008643*	0.003701	0.003435	0.008887*
	(2.36)	(1.15)	(2.40)	(1.15)	(1.19)	(2.17)
Cons	2.365176**	0.914940	1.825684*	0.914940	0.683709	4.435357***
	(3.23)	(1.23)	(2.47)	(1.23)	(1.09)	(4.75)
Control variable	YES	YES	YES	YES	YES	YES
N	6166	7503	6445	7503	9840	3829
R^2	0.1028	0.1187	0.1188	0.1187	0.1184	0.1153

variable. In certain scenarios, the measurement of the original variable might be subject to bias, and substituting it with another highly correlated variable can test the sensitivity of the initial estimation results. Drawing from relevant literature, the study replaces the metric for environmental regulation intensity from "Environmental Pollution Control Investment/GDP" with "Environmental Pollution Control Investment/ Industrial Added Value". The results in Table 2, Model (5), show that the substituted variable for environmental regulation maintains a significantly positive coefficient at the 1% level, further substantiating the positive role of environmental regulation in enhancing residents' life satisfaction.

Additionally, the study addresses potential sample size concerns by excluding data from provinces with respondent samples less than 100 to test the model's robustness. The results in Table 2, Model (6), indicate that the model's outcomes remain largely consistent with the original model after the exclusion of certain samples, with the coefficient for environmental regulation still significantly positive at the 5% level.

Finally, the study employs an instrumental variable approach to address potential endogeneity issues. Despite the inclusion of a comprehensive set of control variables to mitigate the impact of omitted variable bias, there may still be concerns regarding endogeneity, including possible bidirectional causality between environmental regulation and residents' life satisfaction, or the influence of unobserved variables on both. Drawing from the findings of related literature [50], the frequency of the term "environmental protection" in government work reports indirectly reflects the level of government attention to environmental issues, which in turn can enhance the intensity of environmental regulation. Therefore, the study uses the frequency of the term "environmental protection" in government work reports as an instrumental variable (IV) for environmental regulation and conducts a Two-Stage Least Squares (2SLS) regression. This metric not only comprehensively measures the intensity of local government environmental governance but also, due to the timing of government work reports—typically occurring at the beginning of the year—helps mitigate endogeneity issues, as residents' life satisfaction for the year cannot retroactively influence the pre-determined content of the government work reports. The results in Table 2, Model (7), show that even after accounting for endogeneity, the positive impact of environmental regulation on residents' life satisfaction remains highly significant.

Heterogeneity Analysis

In the heterogeneity analysis, the study aims to explore the differential impact of environmental regulation on the life satisfaction of various resident groups. The results in Table 3, which categorizes samples based on respondents' age, urban/rural differences, and educational levels, help identify which groups benefit more from environmental regulation, thereby providing a basis for the development of more targeted environmental policies.

The results in Table 3, Models (1) and (2), show that the impact of environmental regulation on the life satisfaction of younger groups is more pronounced, while older groups are less sensitive to the positive effects of environmental regulation. The results in Table 3, Models (3) and (4), indicate that the effect of environmental regulation on improving life satisfaction is more evident among urban residents and does not significantly impact rural residents. Lastly, the study divides the samples into two groups based on educational level: below 5 points (high school and below) and 5 points and above (college and above). The results in Table 3, Models (5) and (6), show that the enhancing effect of environmental regulation on the life satisfaction of highly educated groups is more significant, while the life satisfaction of those with lower educational levels does not see a substantial improvement. The differences among various groups suggest that when formulating and implementing environmental policies, it is necessary to consider the specific needs and sensitivities of different resident groups. Policymakers should pay attention to those groups that benefit more from environmental regulation while not neglecting those who benefit less. Through

Table 4. Results of the regression of the mediation effects.

Variable	(1)	(2)	(3)	(4)
	Pollution	Satisfaction	Health	Satisfaction
Environment	-0.027636***	0.005598*	0.008080**	0.004735*
	(-3.61)	(2.36)	(2.70)	(2.02)
Pollution	–	-0.005228*	–	–
	–	(-1.97)	–	–
Health	–	–	–	0.124663***
	–	–	–	(18.59)
Cons	21.203247***	1.455493**	5.062042***	0.713589
	(12.61)	(2.78)	(7.71)	(1.38)
Control variable	YES	YES	YES	YES
N	13669	13669	13669	13669
R^2	0.0136	0.1192	0.1443	0.1407

more targeted policy design, it is possible to more effectively enhance the life satisfaction of all residents and maximize the overall welfare of society.

Mechanism Analysis

The objective of mechanism analysis is to elucidate the intrinsic pathways through which environmental regulation impacts residents' life satisfaction. This paper explores the potential mechanisms by which environmental regulation influences residents' life satisfaction, using a mediation effect regression model.

Initially, this paper analyzes the impact of environmental regulation on residents' perception of pollution. The results in Models (1) and (2) of Table 4 indicate that an intensification of environmental regulation significantly reduces residents' perception of pollution. Subsequently, this paper investigates the direct effect of pollution perception on residents' life satisfaction. It is found that the coefficient for pollution perception is significantly negative, implying that the lower the perception of pollution, the higher the life satisfaction of residents. This result suggests that environmental regulation, by diminishing environmental contamination, effectively lowers residents' perception of pollution, which may consequently enhance their life satisfaction. Furthermore, this paper examines the influence of environmental regulation on self-rated health. The results in Models (3) and (4) of Table 4 show that an increase in the intensity of environmental regulation significantly improves residents' self-rated health levels. Concurrently, the impact of self-rated health on residents' life satisfaction is also found to be positively significant. This finding indicates that environmental regulation indirectly raises residents' life satisfaction by elevating their self-rated health levels.

Discussion

As society increasingly focuses on environmental issues, the impacts of environmental regulation have been extensively studied. However, most existing studies either focus on the impact of environmental regulation on the economy and environment, investigate the impact of environmental pollution on residents' life satisfaction and happiness, or merely consider environmental regulation as a moderating variable between environmental pollution and residents' life satisfaction [21, 22]. Direct exploration of the relationship between environmental regulation and life satisfaction is relatively scarce. In this paper, large-scale empirical data (CFPS-2020) is used to directly analyze the relationship between the above two, making the conclusion more reliable and convincing. Starting from residents' subjective cognition, this research deeply analyzes, both theoretically and empirically, how environmental regulation can improve residents' subjective environmental cognition (pollution perception and self-rated health) to enhance their life satisfaction, providing a new perspective for understanding the social benefits of environmental regulation. Furthermore, this paper also examines differences among various groups (such as urban/rural areas, age, and education level), making the conclusions more comprehensive and detailed. In contrast, although some studies have mentioned that environmental conditions may have an impact on residents' work and life [38, 43], they often lack in-depth mechanism discussion. This study, therefore, offers valuable insights for the government in formulating and implementing environmental policies.

Conclusions and Policy Implications

Conclusions

This study, grounded in the China Family Panel Studies (CFPS-2020) data and complemented with relevant provincial macro-indicators, has conducted an in-depth examination of the impact of environmental regulation on residents' life satisfaction. It has also provided an analysis from the perspective of residents' subjective cognition regarding the underlying mechanisms of this impact. The findings of the study reveal that environmental regulation significantly enhances the life satisfaction of residents, with this positive effect being particularly pronounced among urban residents, younger demographics, and those with higher levels of education. Moreover, through the mediation effect analysis, this paper has identified that environmental regulation indirectly impacts residents' life satisfaction by reducing their pollution perception and improving their self-rated health.

Policy Implications

First, the government should enhance the supervision and enforcement of environmental regulations to ensure their effective implementation. This includes improving the training and equipment of enforcement personnel, establishing robust monitoring mechanisms, increasing penalties for environmental violations, and fostering coordinated efforts across departments.

Second, the government should elevate environmental monitoring standards, promptly release environmental quality data, and use various media platforms to interpret and promote environmental information, which will help to increase public understanding and trust in environmental regulation policies. Additionally, promoting environmental science education and encouraging public participation in environmental improvement activities can also foster a sense of responsibility and support for government policies.

Third, given the significant differences among various groups, it is essential to develop precise environmental improvement measures tailored to different resident groups. This can be done by conducting research to understand specific needs and expectations and designing educational content and formats that cater to different levels of environmental awareness and knowledge.

Research Limitations

While this paper delves into the impact of environmental regulation on residents' life satisfaction and the underlying mechanisms using the extensive CFPS-2020 dataset, several limitations are acknowledged. First, it focuses on the immediate impact of environmental regulation on residents' life satisfaction, overlooking long-term and cumulative effects. Additionally, this paper uses a general approach to measure environmental regulation, potentially missing specific policy details. Furthermore, the study primarily considers residents' pollution perception and self-rated health as mediation variables, possibly disregarding other possible mediation factors.

Future Prospects

In response to the limitations identified in this study, future research can be advanced and intensified by focusing on the following dimensions. Future studies should obtain detailed and longitudinal environmental regulation data to better understand its impact on life satisfaction, encompassing a spectrum of policy categories, implementation phases, and enforcement intensities. Additionally, research should examine additional mediating factors, such as environmental behavior and social responsibility. Considering the economic implications of environmental regulation enforcement, it is imperative to conduct systematic evaluations of the outcomes of various environmental policies, providing a basis for more effective government regulations.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical Approval

The CFPS project is approved by the Biomedical Ethics Committee of Peking University (IRB00001052-14010).

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