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How Environmental Regulation Affects Rural Residents' Willingness to Pay for Sustainable Domestic Sewage Treatment: Mediating and Interaction Effects

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Abstract: Exploring the construction of effective payment mechanisms for rural residents could break the dilemma of the value of a single investment by the government in environmental governance and promote the process of sustainable rural domestic sewage treatment (RDST). The effects of environmental regulations have been roughly approved; however, their influence mechanisms on rural residents' willingness to pay (WTP) and payment level for sustainable RDST have not been fully revealed. Based on a database of 744 respondents, an integrated model was developed to verify the heterogeneous effects of three environmental regulations on rural residents' WTP and further explore their interaction effects and impact mechanisms. In addition, there is an urgent necessity to explore the effectiveness of implementing different combinations of environmental regulations. Our results indicated that, firstly, the guiding regulation and incentive regulation promoted rural residents' WTP and payment level, whereas the binding regulation had a limited impact on individuals. Secondly, rural residents' cognition mediated the effect of the environmental regulations on their WTP and payment level. Lastly, the guiding and incentive regulations showed a substitution relationship, while both guiding and binding regulations as well as incentive and binding regulations revealed a complementary relationship. The implications of these results indicate the importance of strengthening the public attention on the environmental and health hazards of rural domestic sewage and effectively raising rural residents' environmental cognition and environmental protection awareness, thereby increasing their WTP and payment level for sustainable RDST. This study provides credible references and recommendations for environmental regulations' formulation and policy optimization for RDST, as well as for the construction of payment systems for rural residents, and inspiration for rural environment management in other developing countries.

Keywords: rural domestic sewage treatment; willingness to pay; environmental regulations; mediating effect; interaction effect

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1. Introduction

A significant amount of waste that pollutes the environment has been created along with global economic progress, social advancement, and growth in population [1]. Currently, more than 80% of the total sewage is directly released into the environment on a worldwide scale [2]. This phenomenon is more severe in rural areas due to the constraints of capital investment, the limitation of residents' awareness, and other factors [3]. In China, more than 500 million people live in rural areas [4]; with the improvement of living

standards and lifestyle transformation, the raising use of washing machines and showers has intensified the generation of rural domestic sewage. Mu et al. [5] demonstrated a 63.27% increase in rural domestic sewage discharge in China from 2010 to 2020. In addition, untreated rural domestic sewage may contain detergents, pesticides, antibiotics, and a variety of micropollutants [6–9]. Large amounts of untreated rural sewage released into the environment will not only cause water body eutrophication, soil degradation, and other potential risks for agricultural productivity, but also threaten animal and human health [10–12]. Therefore, rural domestic sewage treatment (RDST) is an essential initiative to preserve the rural living environment and enhance the welfare of rural residents.

Nowadays, the Chinese government attaches great importance to RDST and proposed the "*Three-Year Action Plan for Rural Living Environment Improvement*" in 2018. Relying on government investment, by the end of 2020, nearly 25.5% of administrative villages established RDST facilities nationwide, and this figure is expected to reach 40% by 2025 [13]. However, the local governments in less economically developed regions are facing a dilemma in affording substantial RDST capital investment [14], which has resulted in a relatively slow expansion of RDST. Due to fiscal deficits, some governments lack the financial ability to cover the expenditures for the operation and maintenance of completed RDST facilities, which has led to a substandard sewage treatment and impeded the sustainability of RDST [15]. Therefore, on the basis of the current RDST achievements and the importance of the numerous constructed RDST plants, it is significant to broaden the funding channels to contribute to safeguarding RDST and establish a long-term operation and maintenance plan for sustainable RDST.

Rural residents are not only the "dischargers" of rural domestic sewage, but also the direct "beneficiaries" of RDST [16]. Therefore, based on the "polluter pays" principle, exploring additional funding options, such as rural residents' willingness to pay (WTP) for environmental management, has been regarded as an important way to break through the constraint of insufficient government financial investment [17]. In addition, due to the relatively low levels of Chinese rural residents' WTP and payment for environmental management [18], there is an urgent need for an in-depth analysis of the WTP and payment level's influencing factors and their mechanisms of action. Exploratory studies were conducted globally on the internal influencing factors of rural residents' WTP and payment level regarding RDST. These studies are mainly focused on individual and family characteristics [19,20], peasant class identity [16], and capital endowment [17,21]. In addition, the influence of rural residents' environmental cognition on their willingness to participate in rural environmental management has also attracted academic interest, and it has been generally confirmed that the higher the rural residents' environmental cognition, the stronger their willingness to participate in rural environmental management [22,23]. Moreover, it is also suggested that the environmental cognition of rural residents should be improved through education, guidance, and the formulation of environmental regulations, so as to achieve soft restraints at the moral level and strong restraints at the policy level [24].

Rural residents who improperly treat rural domestic sewage will cause environmental pollution; failure to compensate for the damage caused by environmental pollution will result in negative environmental externalities [25]. The government, as a representative of the public interest, could balance the marginal costs and marginal benefits of rural residents' participation in environmental management by implementing environmental regulations such as taxes or economic subsidies, thus internalizing the externalities of environmental pollution [26,27]. However, although the Chinese governments at all levels have implemented a variety of environmental regulations for rural environmental management, the dispersed, hidden, and lagging characteristics of surface pollution in rural environments, as well as the government's lack of financial resources and other factors, may result in a "regulatory failure" phenomenon [28,29]. Therefore, it is particularly important to explore the effectiveness of different environmental regulations on rural environmental management. In terms of the impact of environmental regulations on rural environment management and, particularly, on sustainable RDST, the existing studies have the following limitations.

Firstly, most of the current research on the impact of environmental regulation focuses on domestic waste management [18,30] or livestock and poultry manure management [31,32], while studies on the impact of environmental regulations on RDST are relatively insufficient. Secondly, the impact of environmental regulations—a crucial influence factor of rural residents' WTP and payment level regarding sustainable RDST—on individuals and their influence mechanisms have been relatively underexamined. Finally and most importantly, as different environmental regulations regarding RDTS currently exist, their interactions need to be further explored. Although some scholars analyzed the impact of individual environmental regulations on rural residents' participation in environmental management or the interaction of environmental regulation with informal regulation and social norms [18,33–36], the effects of the interaction between diverse environmental regulations have not been analyzed thoroughly.

To solve the above dilemmas, this study responds to the following scientific questions: "what are the individual and interaction effects of diverse environmental regulations on rural residents' WTP and payment level for sustainable RDST?"; and "what are the influence mechanisms of different environmental regulations on rural residents' WTP and payment level?". Therefore, the objectives of this study were as follows. Firstly, based on on-site survey data, this study applied the binary logit regression model and the Tobit model to indicate the heterogeneous impact of the guiding, incentive, and binding regulations on rural residents' WTP and payment level regarding sustainable RDST, respectively. Secondly, a mediation effect model was constructed, and the influence mechanism of the environmental regulations on rural residents' WTP and payment level was revealed. Finally, based on an interaction effect model, the interaction effects of different combinations of environmental regulations on rural residents' WTP and payment level were further analyzed. This study contributes to clarifying the heterogeneous impacts of different environmental regulations on rural residents' WTP and payment level regarding sustainable RDST, exploring the impact mechanisms and realization paths of different environmental regulations, as well as provides references to the government for the formulation of different environmental regulation combinations. Furthermore, the study results could provide references for rural living environment management in other developing countries and contribute to the realization of the UN Sustainable Development Goal "clean water and sanitation for all" (SDG 6).

2. Theoretical Framework

2.1. Effects of Environmental Regulations on Rural Residents' WTP and Payment Level for Sustainable RDST

Due to the relatively low environmental protection consciousness and income level of rural residents, the majority of rural areas have not established a payment mechanism for rural residents regarding RDST [18]. Therefore, governments need to intervene, and environmental regulation is one of the main instruments. The theory of externalities could also provide the basis for environmental regulations' implementation by the government. The environmental pollution caused by rural domestic sewage has negative externalities; so Li et al. [28] suggested that the externalities of environmental pollution should be internalized. Pigou [37] emphasized the importance of direct regulation by the government, advocated the internalization and elimination of negative externalities through taxation and subsidies, and provided a direct scheme to adopt environmental regulations. As an important instrument of government intervention for pollution externalities, environmental regulation has been found to have a significant impact on rural domestic waste sorting, livestock and poultry waste management, and other aspects [32,38].

In terms of rural environmental management, the common environmental regulations are mainly guiding regulation, incentive regulation, and binding regulation. Firstly, as regards the guiding environmental regulation, the government mainly publicizes the negative consequences of environmental pollution and the significance of environmental protection among rural residents through environmental protection publicity and education. These

approaches may raise rural residents' environmental knowledge and literacy and enhance the public understanding and acceptance of policies, thereby reducing policy violation behaviors and thus improving rural residents' WTP and payment level for sustainable RDST [18,23,39]. Secondly, regarding the incentive environmental regulation, the government directly reduces the transaction cost of rural residents' participation in sustainable environmental management to a certain extent by issuing pollution control subsidies and material rewards and promoting stable economic expectations [40,41]. Greater incentives enable rural residents to participate in sustainable RDST, which means that rural residents' WTP and payment level will increase. Lastly, with respect to the binding environmental regulation, penalties are the most common means of binding. Rural residents will be penalized with fines or other penalties if they deviate from the regulatory norms. Rural residents will be more likely to accommodate to the regulatory objectives on the basis of economic rationality after considering the non-compliance cost and will be driven by loss aversion to participate in sustainable RDST, thus increasing their WTP and payment level [42]. According to the above analysis, the following hypotheses are proposed:

H1a. *The implementation of the guiding regulation has a positive impact on rural residents' WTP and payment level for sustainable RDST.*

H1b. *The implementation of the incentive regulation has a positive impact on rural residents' WTP and payment level for sustainable RDST.*

H1c. *The implementation of the binding regulation has a positive impact on rural residents' WTP and payment level for sustainable RDST.*

2.2. Mediating Effects of Rural Residents' Cognition on Their WTP and Payment Level for Sustainable RDST

The cognition of rural residents is the foundation of their participation in environmental management, and their willingness and attitude to participate are formulated on the basis of certain environmental cognitions [27]. It is believed that improving the level of rural residents' cognition has a significant impact on changing their environmental behaviors as well as on increasing their WTP and payment level for rural environmental management [43]. According to Jiao et al. [24], rural residents' cognition of rural domestic sewage is mainly reflected in three aspects, which are necessity cognition, pollution cognition, and health cognition. Rural residents make judgments based on their cognition of the environmental problems caused by the discharge of untreated domestic sewage. The assessment of the necessity for domestic sewage treatment, pollution of the environment, and the impact of pollution on human health leads to a decision on whether to implement environmentally friendly behaviors [38,39]. In addition, improving sustainable environmental management among rural residents is a long-term process. It mainly aims to encourage rural residents to establish the value of environmental protection and cognition of environmental protection by disseminating relevant sustainable environmental management knowledge and enhancing environmental perception, so to improve rural residents' WTP and payment level [44]. The implementation of environmental regulations contributes largely to residents' environmental cognition and may indirectly affect their WTP and payment level for sustainable environmental management. Therefore, environmental regulations not only have a direct effect on rural residents' WTP, but also indirectly affect rural residents' WTP and payment level by influencing their cognition. Based on the above analysis, the following hypotheses were formulated:

H2. *Rural residents' cognition is the mediator of the effect of environmental regulation on rural residents' WTP and payment level for RDST.*

2.3. Interaction Effects of Environmental Regulations on Rural Residents' WTP and Payment Level for Sustainable RDST

In the current process of rural environmental management, different types of environmental regulation may interact mutually [45]. In the context of the coexistence of multiple environmental regulations, the combination of different types of environmental regulation may result in certain functional overlaps or differences, thus presenting different interaction effects [46]. Li et al. [47] concluded that the interaction of different formal institutions and different informal institutions had heterogeneous and significant effects on farmers' green production behaviors, in which the disciplinary supervision of the informal institutions showed a substitution relationship with the binding regulation of the formal institutions, and the value guidance of the informal institutions showed a complementary relationship with the binding regulation of the formal institutions. Specifically, the guiding regulation emphasizes the importance of raising the awareness of environmental protection among rural residents, as well as of enhancing their understanding of the incentive and binding regulations, thus reducing the understanding bias against the incentive and binding regulations among rural residents. This may increase the acceptance and recognition of the incentive regulation and binding regulation by rural residents, which consequently may increase the promotional effect of the incentive regulation and binding regulation on rural residents' WTP and payment levels regarding sustainable RDST. In addition, the incentive and binding regulations may award or penalize the rural residents to some extent, either financially or reputationally. When faced with the prospect of being rewarded or penalized, rural residents may be motivated by the incentive regulation and binding regulation to pay more attention to the information and education provided by the guiding regulation, which may strengthen the effect of the guiding regulation on the promotion of rural residents' WTP and payment levels for sustainable RDST. Therefore, different environmental regulations interact with each other to promote rural residents' WTP and payment level for sustainable RDST. Accordingly, the following hypothesis is proposed.

H3. *There is an interaction effect of different environmental regulations on rural residents' WTP and payment level for sustainable RDST.*

According to the above theoretical analysis and hypotheses, a research framework covering the effects of three environmental regulations, rural residents' cognition, and the interaction between different environmental regulations on rural residents' WTP and payment level for sustainable RDST was conceptualized, and the influencing pathways are shown in Figure 1.

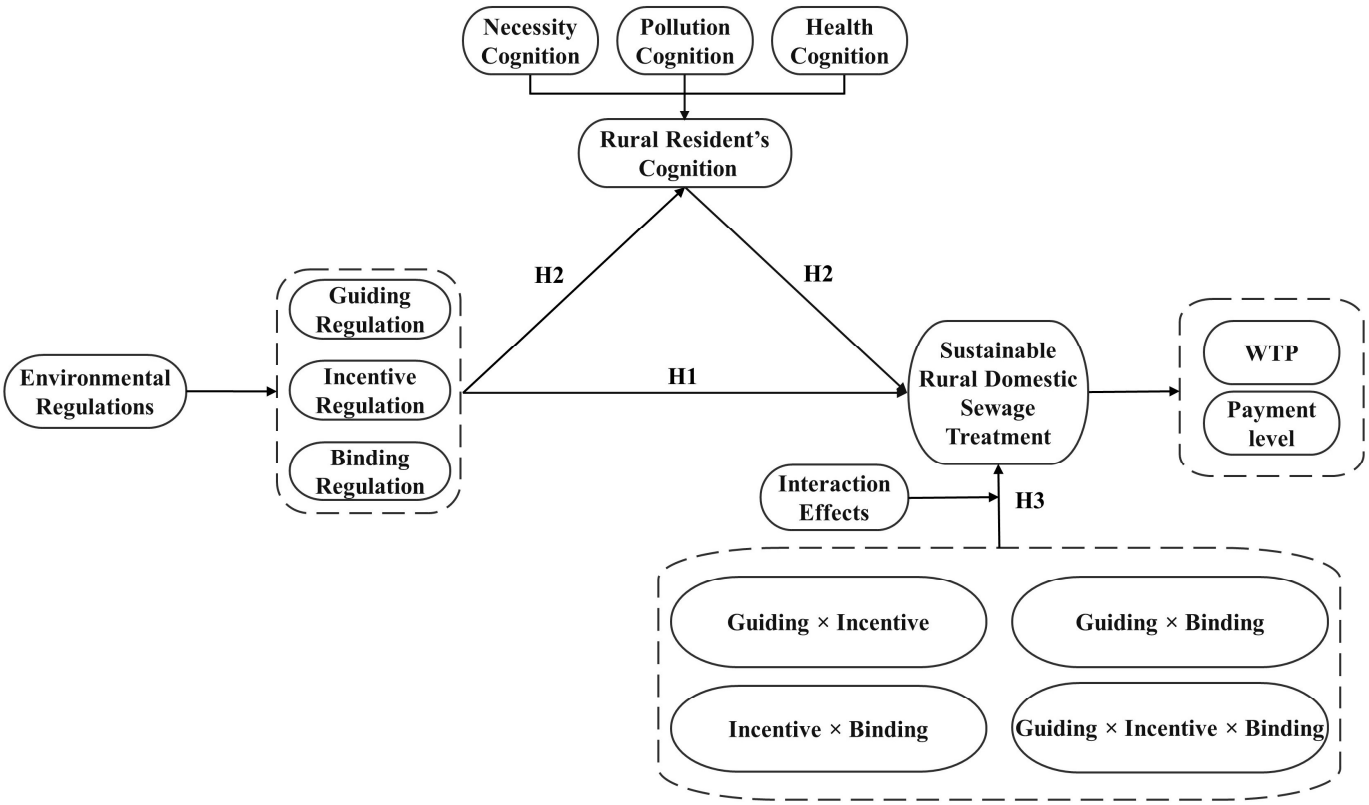

Figure 1. Framework of the relationship between environmental regulation and rural residents' WTP and payment level for RDST.

3. Materials and Methods

3.1. Data Collection

The data examined in this study were collected from northern China from September to November 2020. Due to the relatively low level of economic development in northern China compared with southern China, the government's financial resources in this region are relatively insufficient, and the funding shortage for RDST and other issues is more serious. In addition, the urbanization rate in northern China is relatively slow, with a relatively high percentage of rural population. Therefore, it appeared to be more practical to select northern China to conduct investigations on the described research topic. Based on the per capita income of rural residents, provinces in northern China were classified into three grades: high, medium, and low. We selected one province per each grade, i.e., Shandong Province, Jilin Province, and Gansu Province (Figure 2), as the study area for this research (Table 1). These three provinces are all crucial agricultural development areas in China, with a relatively high proportion of rural population. In addition, these provinces are located in different geographical regions of northern China, which include the North China Plain, the Northeast China Plain, and the Loess Plateau. Therefore, the obtained results could also provide experiences and implications for the entire North China or even for developing countries with similar characteristics, such as India or some African countries.

In order to avoid a sample selection bias, this study used a stratified random sampling method based on the level of economic development of each region. We selected three counties in each province, three townships in each county, and three administrative villages in each township. For each village, we interviewed 8 to 10 adults who were permanent residents of the village. In consideration of the variability in respondents' educational levels, a face-to-face questionnaire interview for each respondent was required to ensure the data authenticity and validity. Eventually, a total of 798 questionnaires were collected, and after excluding inconsistencies and missing values, 744 valid questionnaires were obtained

for the analysis, with a questionnaire effectiveness rate of 93.23%. The Jilin, Shandong, and Gansu provinces provided 30.11%, 34.68%, and 35.21% of the samples, respectively.

The questionnaire consisted of four parts. The first section included the individual characteristics of the respondents, including gender, age, education level, village cadre membership, and household income. The second part is the core variable of this study and regarded environmental regulations. The third part investigated the mediating variables of this study, namely, the respondents' cognition of RDST. Rural residents' cognition was mainly expressed by three sub-indicators, i.e., rural residents' awareness of the necessity and of the pollution and health implications of RDST. The fourth part aimed to reveal the WTP and payment level for sustainable RDST of rural residents.

Table 1. Socioeconomic statistics of the study area in 2020.

Study Area	Rural Population (Million)	Proportion of Rural Population (%)	Rural Disposable Income (CNY [1]/Person·Year)
Jilin	8.99	37.47%	16,067.0
Shandong	37.51	36.90%	18,753.2
Gansu	11.95	47.78%	10,344.0
China	509.79	36.10%	17,131.5

Note: [1] CNY, Chinese yuan, 1 CNY = 0.14 USD (1 September 2023).

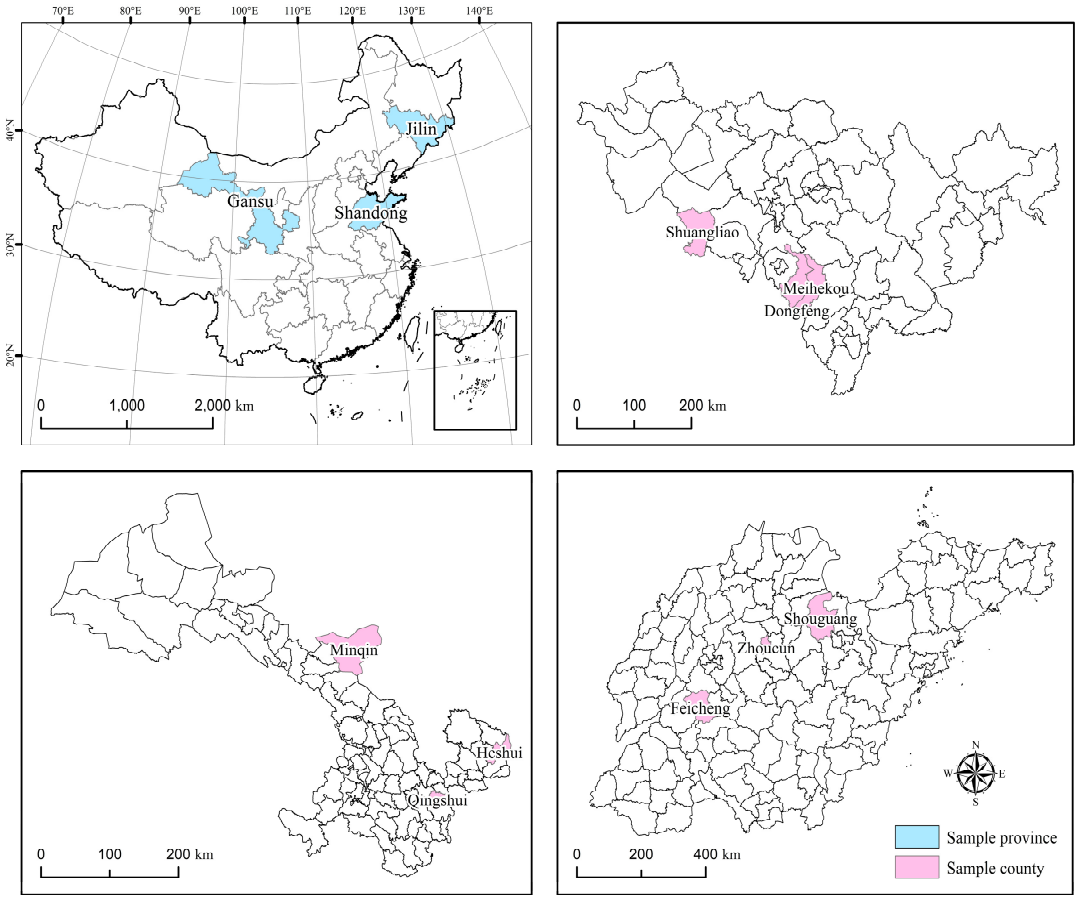

Figure 2. Distribution of the study area in China.

3.2. Variable Selection

In this study, the dependent variables were rural residents' WTP and payment level for sustainable RDST; additionally, environmental regulations as core independent variables,

rural residents' cognition as a mediating variable, socio-economic characteristics variables, and regional variables were considered (Table 2).

The average age of the respondents of this survey was approximately 54 years, their average level of education was junior school level, and the average annual household income was approximately CNY 54,000. This is also consistent with Chinese government statistics on rural residents [48]. Therefore, the samples of this study could broadly represent the residents of rural areas of northern China.

Table 2. Variables' definitions and descriptive statistics.

Variable	Definition	Mean
Willingness to pay	Are you willing to pay for sustainable RDST? 0 = No, 1 = Yes	0.835
Payment level	How much are you willing to pay per month? (CNY)	8.14
ENVIRONMENTAL REGULATIONS		
Guiding regulation	Does the government or the village advertise the benefits of domestic sewage treatment? 0 = No, 1 = Yes	0.901
Incentive regulation	Does the government or the village use material or verbal incentive measures to encourage rural residents to properly dispose of domestic sewage? 0 = No, 1 = Yes	0.628
Binding regulation	Does the government or the village use any material or verbal penalties regarding the arbitrary discharge of domestic sewage by rural residents? 0 = No, 1 = Yes	0.224
RURAL RESIDENTS' COGNITION *		
Necessity cognition	Is it necessary to treat domestic sewage?	3.902
Pollution cognition	Does domestic sewage pollute the environment?	3.362
Health cognition	Does domestic sewage have an impact on health?	3.325
SOCIO-ECONOMIC CHARACTERISTICS		
Gender	Gender of the respondent; 0 = Female, 1 = Male	0.700
Age	Age of the respondent	54.113
Education level	Education level of the respondent; 1 = Illiteracy, 2 = primary, 3 = junior, 4 = high school, 5 = college and above	2.956
Village cadres	Are you a member of village cadres? 0 = No, 1 = Yes	0.202
Household income	Respondents' annual household income (10,000 CNY)	5.354
REGIONAL CHARACTERISTICS		
Jilin Province	0 = Other, 1 = Jilin	0.301
Shandong Province	0 = Other, 1 = Shandong	0.347
Gansu Province	0 = Other, 1 = Gansu	0.352

Note: * Respondents' answers were scored according to a positive five-point Likert-type scale (1 = total disagree, 2 = somewhat disagree, 3 = neither disagree nor agree, 4 = somewhat agree, 5 = total agree). To reduce the collinearity between the indicators, dimensionality reduction was performed for factor analysis; the results showed that the Kaiser–Meyer–Olkin statistic was 0.651, with a p-value of 0.000 from the Bartlett's sphericity test. The obtained common factor was defined as "rural residents' cognition".

3.3. Empirical Models

3.3.1. Baseline Regression Model

In this study, two main aspects were examined to explore the willingness of rural residents to implement sustainable RDST. Firstly, the binary logit regression model was applied to test whether diverse environmental regulations contributed to rural residents'

WTP for sustainable RDST. Since there were only two responses to evaluate the rural residents' WTP, i.e., "Yes" and "No", this was a discrete choice problem; so, based on the study of Xu et al. [18], a binary logit regression model was used for the estimation (Equation (1))

$$WTP_i = \alpha_0 + \alpha_1 ER_i + \alpha_2 Control_i + \varepsilon_1 \quad (1)$$

where WTP_i represents rural residents' WTP; ER_i denotes various types of environmental regulations; $Control_i$ is the control variable that may affect rural residents' WTP; and ε_1 is the error term.

Secondly, the response of rural residents regarding the payment level for sustainable RDST indicated the actual amount of money they were willing to pay per month, which was a continuous variable; therefore, it was more appropriate to use the Tobit model. In addition, as left censoring was zero due to the fact that approximately 16.5% of the respondents in the survey refused to pay, this issue could be well addressed by the Tobit model. According to He et al. [49], the related equation is as follows:

$$Payment_i = \alpha_0 + \alpha_1 ER_i + \alpha_2 Control_i + \varepsilon_1 \quad (2)$$

where $Payment_i$ represents the actual payment amount of rural residents regarding sustainable RDST, and the rest of the terms are the same as in Equation (1).

3.3.2. Mediating Effect Model

Supposing that α_1 in Equations (1) and (2) is significant, the impact path of environmental regulations affecting rural residents' WTP and payment level would be revealed by verifying the mediating effect of rural residents' cognition. Based on the mediating effect model of Baron and Kenny [50] and Wen and Ye [51], this study employed a stepwise regression model to test the influence of the relationship between rural residents' cognition of environmental regulation and WTP

$$Cognition_i = \beta_0 + \beta_1 ER_i + \beta_2 Control_i + \varepsilon_2 \quad (3)$$

$$WTP_i = \gamma_0 + \gamma_1 ER_i + \gamma_2 Cognition_i + \gamma_3 Control_i + \varepsilon_3 \quad (4)$$

$$Payment_i = \gamma_0 + \gamma_1 ER_i + \gamma_2 Cognition_i + \gamma_3 Control_i + \varepsilon_3 \quad (5)$$

In the model, Equation (3) explains the relationship between rural residents' cognition and environmental regulations. If β_1 is significant, then it is possible to test whether both environmental regulations and rural residents' cognition are related to WTP and payment level by Equations (4) and (5). If γ_1 and γ_2 are significant, a mediation effect exists. In addition, since rural residents' cognition is a continuous variable, Equation (3) is estimated by ordinary least squares (OLS) regression.

3.3.3. Interaction Effect Model

The effects of environmental regulations on rural residents' WTP and payment level for sustainable RDST are not independent. Therefore, this study further explored whether there were interaction effects of different types of environmental regulation on rural residents' WTP and payment level. Based on the approach of Sun et al. [52], this study tested the interaction effects by incorporating the interaction terms of different environmental regulations into the model. The specific equations are as follows

$$WTP_i = \theta_0 + \theta_1 ER_1 + \theta_2 ER_2 + \theta_3 ER_1 * ER_2 + \theta_4 Control_i + \varepsilon_4 \quad (6)$$

$$Payment_i = \theta_0 + \theta_1 ER_1 + \theta_2 ER_2 + \theta_3 ER_1 * ER_2 + \theta_4 Control_i + \varepsilon_4 \quad (7)$$

where $ER_1 * ER_2$ indicates the interaction of different environmental regulations, and θ_3 indicates the interaction effect of different environmental regulations on rural residents'

WTP and payment level. If the value of θ_3 is significant, then the existence of interaction effects is proved.

4. Results

4.1. Descriptive Statistics of Rural Residents' WTP and Payment Level for Sustainable RDST

As can be seen in Figure 3, the percentage of rural residents with positive WTP in the study area was relatively large, reaching approximately 83.5%. A relatively high percentage of rural residents presented their willingness to pay for sustainable RDST, which provides a basis for the Chinese government to promote and implement a payment system at the later stage. In addition, the payment level of rural residents was also investigated. The average payment levels for the total respondents and the respondents with positive WTP were CNY 8.14/month and CNY 9.75/month, respectively. In terms of percentage, 50.2% of the respondents were willing to pay less than CNY 10 per month for their households, and 45.4% of the respondents were willing to pay CNY 10–20. Only 4.4% of the respondents were willing to pay more than CNY 20 per month. The above statistics indicated that rural residents in the research area have a strong WTP, but their payment level is relatively low, which is also consistent with the results of Yu et al. [21].

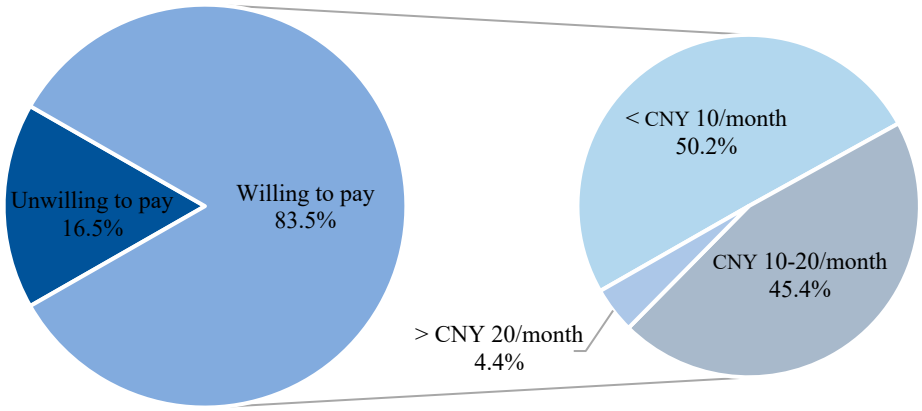

Figure 3. Distribution of rural residents' willingness to pay and proportions of different payment levels.

4.2. Impact of Environmental Regulations on Rural Residents' WTP and Payment Level for Sustainable RDST

Considering the possibility of variables' multicollinearity and ensuring the regression validity, it was necessary to diagnose the variables collinearly. As the results indicated, the variance inflation factor (VIF) of each variable was less than 2, indicating that a serious multicollinearity did not exist among the variables. Subsequently, this study employed binary logit regression to analyze the determinants of rural residents' WTP for sustainable RDST by Stata 17. Table 3 presents the regression results of the effects of different environmental regulations as well as of other control variables on rural residents' WTP and payment level regarding sustainable RDST. In order to provide a convenient explanation for the impact of environmental regulations on the WTP and payment level of rural residents, this table reports the results of marginal effects instead of regression coefficients.

The regression results illustrated that the guiding regulation and the incentive regulation had positive impacts on rural residents' WTP and payment level for sustainable RDST, which verified H1a and H1b. This might be attributed to the fact that a clear and consistent guiding regulation enabled rural residents to better understand their responsibilities and obligations as well as to acquire environmental knowledge. On this basis, there was a corresponding increase in the probability of rural residents' WTP and payment level for sustainable RDST. For the incentive environmental regulation, subsidies, grants, and tax credits were usually the main approaches, which may reduce the cost of participation in sustainable RDST for rural residents, thereby increasing their WTP and payment level.

These findings are also consistent with the results of Tang et al., who concluded that a guiding regulation could increase rural residents' environmental cognition, and an incentive regulation could reduce the participation cost, thus enhancing rural residents' willingness to participate in rural environmental management [27]. However, the incentive environmental regulation is potentially a double-edged sword. Governments should be aware that rural residents may not perceive the benefits of investing in sewage treatment systems if the incentives are deemed excessively limited or insufficient to cover the treatment expenditure. The marginal effect results revealed that the probability of rural residents' WTP increased by 18.2% and 12.7% in villages with the implementation of guiding and incentive regulations, respectively, and the level of payment increased by CNY 4.26 and CNY 1.10. This may be due to the fact that while the incentive regulation may reduce the participation cost of rural residents for sustainable RDST, the guiding regulation transforms the environmental cognition and enhances the environmental knowledge of rural residents so that they are intimately more willing to pay for sustainable RDST.

Table 3. Binary logit regression results of the effects of government regulations on rural residents' WTP and payment level.

Variable	Logit	Tobit	Logit	Tobit	Logit	Tobit
	WTP	Payment	WTP	Payment	WTP	Payment
Guiding regulation	0.182 ***	4.225 ***	--	--	--	--
Incentive regulation	--	--	0.127 ***	1.096 ***	--	--
Binding regulation	--	--	--	--	−0.030	−0.468
Gender	−0.010	0.587	−0.002	0.723	−0.003	0.724
Age	−0.004 ***	−0.071 ***	−0.006 ***	−0.096 ***	−0.007 ***	−0.098 ***
Education level	0.048 ***	0.349 *	0.073 ***	0.635 ***	0.076 ***	0.676 ***
Village cadres	0.099 ***	0.386	0.140 ***	0.672	0.131 ***	0.549 ***
Household income	0.021 ***	0.138 ***	0.027 ***	0.157 ***	0.029 ***	0.159 ***
Jilin Province	−0.038	−2.867 ***	−0.033	−2.930 ***	−0.041	−3.008 ***
Gansu Province	0.021	−2.461 ***	0.027	−2.401 ***	0.041	−2.240 ***
Observations	744	744	744	744	744	744
LR $\chi 2$	229.31 ***	234.29 ***	222.81 ***	186.09 ***	191.68 ***	178.09 ***
Pseudo R^2	0.344	0.051	0.334	0.040	0.287	0.039

Note: *** $p < 0.01$, * $p < 0.1$.

Interestingly, there was a non-significant effect of the binding environmental regulation on rural residents' WTP and payment level for sustainable RDST. Thus, H1c was rejected; the same result was also obtained by Huang et al. [53]. This finding was attributed to the following reasons. Firstly, this phenomenon was probably caused by the ineffective implementation of the government's environmental regulations and by the fact that most of the regulations focused on prohibiting rural residents' behaviors rather than guiding them to participate in environmental management, which resulted in the "relative institutional failure" phenomenon of ineffective environmental regulations [28]. Secondly, the binding environmental regulation may also increase governance costs, and the corresponding penalties may be unaffordable for rural residents with an overly strict regulation. In addition, if regulations are not effectively implemented, rural residents may not perceive the necessity for RDST investment, and this will thus reduce their WTP and payment level. However, in contrast to the findings of this study, some research found that binding regulations have a significant impact on rural residents' participation in rural environmental management and adoption of green production technologies [18,42]. Therefore, in order to further enrich the findings in this area, the implementation scope, application types, and application conditions of the binding regulation need to be further explored in future research.

In terms of control variables, there were four significant variables that affected rural residents' WTP and payment level, i.e., age, education level, village cadre membership, and household income. In particular, the respondents' age negatively affected rural residents' WTP for sustainable RDST, which meant that the younger the respondents were, the higher the probability of them being willing to pay and their payment level. A potential reason for this is that the younger the rural residents, the higher the level of cognition and awareness of environmental management practices such as RDST, and the more likely their participation in RDTS costs. This finding was also reported by other scholars [27]. The respondent's education level positively influenced rural residents' WTP and payment level for sustainable RDST, as education improved their awareness and perception of the importance of environmental conservation. Furthermore, He et al. [54] believe that as a quasi-public good, education may contribute to the improvement of overall environmental protection awareness among the population of an area through positive spillover effects, therefore promoting rural residents' WTP and payment level. Village cadres had a significant positive effect on rural residents' WTP and payment level, which might be because cadres represent the actual facilitators and practitioners of government policies in rural regions and might demonstrate a stronger WTP and payment level, exhibiting a higher ideological cognition and perception of the value of environmental protection [24]. The annual household income also exhibited an effective positive effect on individuals' WTP and payment level, in agreement with Afroz et al. [55], who indicated that wealthier rural residents were more inclined to invest in environmental management.

4.3. Mediating Effect of Rural Residents' Cognition

Preliminary results showed that there was a significant positive direct effect of both guiding and incentive regulations on rural residents' WTP and payment level for sustainable RDST. According to the theoretical analysis and the research hypotheses, the results in this section revealed the mediating effect of rural residents' cognition in the process of different environmental regulations influencing rural residents' WTP and payment level; the mechanisms by which environmental regulations and rural residents' cognition influenced rural residents' WTP for sustainable RDST were further verified. It should be noted that the path "binding regulation–rural residents' cognition–WTP and payment level" was not tested, since the binding regulation showed a non-significant effect on rural residents' WTP and payment level in the above results.

In Table 4, both guiding regulation and incentive regulation positively affected rural residents' cognition and were significant at the 1% level. This suggested that the implementation of environmental regulation contributed to enhancing rural residents' cognition. When rural residents' cognition was included in the regression model of the impact of the guiding regulation on rural residents' WTP and payment level, the effects of both guiding regulation and rural residents' cognition were positively significant at the 1% statistical level. This indicated that rural residents' cognition positively and significantly mediated the effect of the guiding regulation on rural residents' WTP and payment level and confirmed the existence of the influence paths "guiding regulation–rural residents' cognition–WTP" and "guiding regulation–rural residents' cognition–payment level". Similar to the results obtained for the guiding regulation, when rural residents' cognition was incorporated into the regression model of the effect of the incentive regulation on rural residents' WTP and payment level, all regression coefficients were significant, at the 1% level, except for that for the effect of the incentive regulation on the payment level, which was significant at the 5% level. This illustrated that the influence paths of "incentive regulation–rural residents' cognition–WTP" and "incentive regulation–rural residents' cognition–payment level" were also verified. This finding was similarly reported by Yang et al. [56], who argued that rural residents deepen their own environmental cognition during the enforcing of environmental regulations, which thus enhances their WTP for rural environmental management. Thus, rural residents' cognition had a mediating effect in the influencing process of guiding and incentive regulations on rural residents' WTP and payment level;

therefore, H2 was partially confirmed, which means that guiding and incentive regulations indirectly promote rural residents' WTP by enhancing rural residents' cognition.

Table 4. Analysis of the mediating effect of rural residents' cognition.

Variable	Guiding Regulation			Incentive Regulation		
	Rural Residents' Cognition (OLS)	WTP (Logit)	Payment (Tobit)	Rural Residents' Cognition (OLS)	WTP (Logit)	Payment (Tobit)
Guiding regulation	0.570 ***	2.486 ***	7.106 ***	--	--	--
Incentive regulation	--	--	--	0.242 ***	1.750 ***	1.151 **
Rural residents' cognition	--	1.634 ***	2.486 ***	--	1.614 ***	2.622 ***
Control variables	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	744	744	744	744	744	744
LR $\chi 2$	9.57 ***	388.68 ***	334.02 ***	8.61 ***	383.07 ***	295.19 ***
Pseudo R^2	0.094	0.583	0.072	0.086	0.574	0.064

Note: *** $p < 0.01$, ** $p < 0.05$.

As the traditional mediating effect calculation method is not applicable to nonlinear probability models, this paper adopted the KHB method, which was proposed by Karlson et al. [57] and Kohler et al. [58] to measure the mediating effect and effect decomposition of rural residents' cognition. Table 5 reports the results of the KHB model; all results were positively significant at the 1% level. In terms of WTP, the indirect effects of guiding regulation and incentive regulation on rural residents' WTP by influencing rural residents' cognition accounted for 27.25% and 18.26% of the total effects. As for the payment level, the indirect effects of these two environmental regulations accounted for 27.19% and 19.01% of the total effects. In other words, the implementation of these two environmental regulations led to a higher rural residents' cognition, which was reflected in a higher rural residents' WTP. These analyses are consistent with the previous test results, indicating robust results for the mediating effects, and further verified the mechanisms by which diverse environmental regulations and rural residents' cognition may influence rural residents' WTP and payment level for sustainable RDST.

Table 5. Effect decomposition of positive regulations on the impact of rural residents' WTP.

	Guiding Regulation		Incentive Regulation	
	WTP	Payment	WTP	Payment
Total effect	3.417 ***	1.872 ***	2.141 ***	1.136 ***
Direct effect	2.486 ***	1.363 ***	1.750 ***	0.920 ***
Indirect effect	0.931 ***	0.509 ***	0.391 ***	0.216 ***

Note: *** $p < 0.01$.

4.4. Interaction between Diverse Environmental Regulations

Nowadays, in China's rural environmental management practice, there is not a unique environmental regulation, but a variety of environmental regulations coexist. Therefore, this section tested the interaction effects of different environmental regulations, and the results are presented in Table 6. Firstly, the interaction between guiding and incentive regulations exhibited a significant negative effect on both rural residents' WTP and payment level. This suggested that there was a substitution relationship of these two environmental regulations concerning their impacts on rural residents' WTP and payment. This implicated that when the guiding regulation was ineffective, the incentive regulation could work as an alternative to the guiding regulation. In this regard, a possible explanation might be that in areas of weakly implemented guiding regulation, the perception of rural residents

might be at a relatively low level, thus limiting rural residents' WTP and payment level regarding sustainable RDST. However, the implementation of the incentive regulation could economically reduce the cost of rural residents' participation in sustainable RDST and thus increase their WTP and payment level. Secondly, the effect of the interaction between guiding and binding regulations was positively significant, and a similar result was found for the interaction between incentive and binding regulations. This means that the interactions of these two combinations of environmental regulations could promote rural residents' WTP and payment, indicating a complementary relationship. In other words, the implementation of the binding regulation would contribute to the enhancement of the guiding and incentive regulations. This result was probably due to the fact that rural residents, as "rational economic individuals", are more inclined to accept government guidance and receive rewards in the face of the risk of penalties. The above findings are consistent with those of other scholars' related studies, who concluded that there was a significant interaction between two of these three environmental regulations, which means that they significantly moderated each other's influence on rural residents' willingness to engage in rural environmental management [31,45]. Finally, no significant effect on rural residents' WTP and payment level was found when the interaction of the three environmental regulations was included, which also implies that there was no correlation between the three environmental regulations. It also means that when environmental regulation was implemented to an excessive extent, it would be limited in its effectiveness. Thus, based on the above empirical results, H3 was partially validated.

Table 6. Effects of the interaction of diverse environmental regulations.

Variable	WTP	Payment	WTP	Payment	WTP	Payment	WTP	Payment
Guiding regulation (X1)	1.799 ***	7.336 ***	2.189 ***	8.789 ***	--	--	1.820 ***	7.722 ***
Incentive regulation (X2)	1.198 ***	1.604 ***	--	--	1.637 ***	1.668 ***	1.308 ***	1.334 **
Binding regulation (X3)	--	--	0.045	−0.989	1.073	−0.235	0.251	−0.246
X1×X2 (interactive item)	−1.805 **	−8.750 **	--	--	--	--	--	--
X1×X3 (interactive item)	--	--	2.679 **	8.242 **	--	--	--	--
X2×X3 (interactive item)	--	--	--	--	2.596 **	1.899 *	--	--
X1×X2×X3 (interactive item)	--	--	--	--	--	--	−2.004	−8.144
Control variables	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	744	744	744	744	744	744	744	744
LR $\chi 2$	260.63 ***	255.39 ***	237.15 ***	242.85 ***	231.95 ***	188.42 ***	256.51 ***	242.84 ***
Pseudo R^2	0.391	0.055	0.355	0.053	0.348	0.041	0.385	0.053

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Discussion and Limitations

5.1. Feasibility and Contribution of Rural Residents' Payment in the Current Context

This study provides foundations for establishing a payment mechanism for rural residents regarding sustainable RDST. Currently, the average household size in rural China is 2.7 persons [4]. Assuming that the per capita domestic sewage production is 70 L/day [59], the average household domestic sewage discharge is about 5.67 m^3/month. Actually, the RDST maintenance cost in China is approximately from CNY 1.38/m^3 to CNY 3.02/m^3 [60,61]. Therefore, the payment level of rural residents in the study area could cover at least 47.55% of the domestic sewage treatment maintenance cost and even achieve full cost coverage and be profitable in some areas. This also firmly demonstrates the feasibility of establishing a payment mechanism for rural residents for sustainable RDST.

5.2. Mediating Effects Revealed Meaningful Two-Stage Paths

The mediating effect of rural residents' cognition of diverse environmental regulations was verified. This also indicated that a partial impact of environmental regulations on rural residents' WTP and payment was achieved by influencing their cognition. In addition, the existence of the influence mechanism "environmental regulation–rural residents' cognition–WTP and level of payment" for rural residents' participation in RDST was further revealed. The influence mechanism of this mediating effect consisted of the following two phases.

Firstly, environmental regulations had a positive and significant impact on rural residents' cognition, which is consistent with findings in previous studies [27,62]. The guiding environmental regulation is one of the main approaches for the government to publicize the governance of rural human living environment and rural ecological environment protection and appeared to strengthen rural residents' cognition of environmental management, including RDST. In addition, rural residents appeared to be equally motivated to implement the incentive regulation, which would deepen their understanding of the regulation and correspondingly improve their environmental cognition.

Secondly, rural residents' cognition had an impact on their WTP and payment level. Nowadays, with the progress of society and economic development, environmental protection awareness among rural residents is gradually increasing, and therefore the cognition of the importance of RDST is also simultaneously increasing. This finding is also in line with the knowledge–attitude–practice" theory (KAP theory), which states that any behavior is not generated from thin air, but evolves gradually after acquiring relevant knowledge and developing attitudes [63]. In this study, rural residents' cognition of environment protection and RDST was a significant influencing factor on their WTP and payment level for sustainable RDST, and this view is also confirmed by the findings of Uthes and Matzdorf [22], Yang et al. [64], and Su et al. [65]. In addition, since rural living environment improvement, especially RDST, has positive externalities, and the general public benefits from the spillover effects of environmental improvement, a "free-ride" mentality could spread among villagers [66]. Therefore, enhancing rural residents' cognition of the environment and RDST is imperative to eliminate the "free-ride" mentality, thus increasing the probability of rural residents' WTP and payment for sustainable RDST. Meanwhile, the governments are suggested to strengthen publicity and education for rural residents to enable them to recognize the relationship between environmental protection and economic development. Rural environmental improvements may contribute to the development of local tourism, attract investments, create employment opportunities, etc., thereby increasing the agricultural and non-agricultural incomes of rural residents [67,68]. As a consequence of this, rural residents will in turn appreciate the benefits of rural environmental management and strengthen their environmental cognition, which will further increase their WTP and payment level for sustainable RDST.

5.3. Interaction of Different Regulations Informs Innovation in Policymaking

Based on the above analysis of the interaction effects of different environmental regulations, the existence of both substitutional and complementary relationships between them was identified. Firstly, the results indicated that when the implementation of the guiding regulation to disseminate and educate the rural residents about RDST remained relatively ineffective or failed, the impact of the incentive regulation with financial stimulation and other means of reducing the transaction costs of sustainable RDST for rural residents became more prominent. Secondly, it was found that a single implementation of the binding regulation had a non-significant effect on the WTP and payment level of rural residents. However, it had a complementary effect when implemented in conjunction with other two environmental regulations. This was probably due to the fact that rural residents are rational economic persons prone to maximizing benefits [42,69]. Therefore, rural residents may be exposed to a greater risk of benefit loss when the binding regulation is implemented more stringently. Meanwhile, in order to prevent a benefit loss, rural residents may prefer to accept the guiding regulation, which ensures a smaller benefit loss, or the incentive regulation, which may lead to additional benefits. Lastly, the interaction of the three environmental regulations had no significant effect on rural residents' WTP and payment level. This implies that the implementation of an excessive variety of environmental regulations may have a crowding-out effect, thus limiting the effectiveness of the environmental regulations. This phenomenon was also confirmed by the impact of environmental regulation on technological innovation and green technology adoption [70,71]. According to the results of this study, the combination of two environmental regulations is

more effective, with the two regulations being complementary or substitutive to each other, which will further enhance rural residents' WTP and payment level for sustainable RDST. However, the excessive implementation of different types of environmental regulations may expose rural residents to a stricter supervision, which may inhibit their willingness to participate in rural environmental management.

Some limitations remain in this study. Firstly, it was inevitable that a zero payment level was indicated in some responses in the questionnaire survey. This questionnaire did not include questions that might reveal the reasons why some respondents expressed a negative willingness to pay for sustainable RDST. Therefore, future studies are recommended to further explore this issue, thus enabling more comprehensive and in-depth research in this field. Secondly, this study attempted to explore the mechanisms of the effects of diverse environmental regulations on rural residents' WTP and payment level for sustainable RDST. However, due to the complexity of the effects of the environmental regulations, there might exist alternative effect mechanisms. Future studies are recommended to explore multiple effect mechanisms of environmental regulations on rural residents' WTP and payment for sustainable RDST for the purpose of enriching the research results in this research area. Finally, although this study analyzed the impact of different combinations of environmental regulations, it did not further examine their appropriateness in different regions. In the future, relevant studies are suggested to thoroughly explore the heterogeneity and appropriateness of the impacts of different combinations of environmental regulations according to the economic development level and the institutional improvement level of different regions.

6. Conclusions and Policy Recommendations

Based on the data from 744 rural residents in Jilin, Shandong, and Gansu provinces in China, this study verified the impact of three environmental regulations on rural residents' WTP and payment level for sustainable RDST. Subsequently, the heterogeneous and interaction effects of the environmental regulations on rural residents' WTP were examined. Finally, this study empirically demonstrated the impact mechanisms, with rural residents' cognition as the mediating variable. The primary findings are as follows. Firstly, rural residents in the research area showed a relatively high WTP for sustainable RDST, and the proportion of rural residents with a positive WTP was 83.5%. In addition, the rural residents' payment level ranged from CNY 8.14/month to CNY 9.75/month, which was calculated to cover at least 47.55% of RDST maintenance costs. Secondly, the effects of three environmental regulations on rural residents' WTP and payment revealed heterogeneity. Both guiding and incentive environmental regulations demonstrated significant positive effects on rural residents' WTP and payment; however, the effect of the binding environmental regulation remained limited. In terms of effectiveness, the effect of the guiding environmental regulation was stronger than that of the incentive environmental regulation. Thirdly, there was a significant positive effect of rural residents' cognition on rural residents' WTP and payment for sustainable RDST. In addition, rural residents' cognition played a mediating role in the effect of environmental regulation on rural residents' WTP and payment for sustainable RDST. For the guiding and incentive environmental regulations, the mediating effect accounted for 27.25% and 18.26% of the total effect, respectively, as regards rural residents' WTP. With respect to the payment level, the mediating effects were 27.19% and 19.01%, respectively. Lastly, it was found that the pairwise interactions of these three environmental regulations had significant impacts on rural residents' WTP and payment regarding sustainable RDST, but the interaction impact of the three environmental regulations was not significant. In particular, the guiding and incentive regulations showed a substitution relationship, while the guiding and binding regulations and the incentive and binding regulations appeared complementary. Based on the above findings, this study constructed a theoretical model of the influence mechanism of rural residents' WTP on sustainable RDST. The empirical model applied in this study to analyze the impacts of different environmental regulations could be widely employed to assess the impacts of

different institutions on residents' behavioral decision-making. In addition, the results of this study might contribute to implementing policy optimization for the development of public participation systems for rural environmental management in regions or countries that are at the same latitude or in a similar situation as North China.

In light of the above results and discussion, this study proposes the following corresponding policy recommendations. Firstly, a payment mechanism for sustainable RDST should be gradually established for rural residents, with the initial payment amount ranging from CNY 8.14/month to CNY 9.75/month as a reference standard. Secondly, the environmental regulation system for rural areas requires further improvement. In comparison with cities and towns, rural environmental management is relatively backward, and the establishment of environmental regulations is still relatively imperfect, which might reduce the capacity and effectiveness of rural environmental management. Therefore, it is necessary to establish and improve rural environmental regulations based on the characteristics of rural areas. Thirdly, the government should emphasize the differences between various environmental regulations when formulating relevant policies and avoid the single implementation of the binding regulation. Moreover, the combinations of diverse environmental regulations may contribute to improving rural residents' WTP and payment level for sustainable environmental management, but it should be noted that excessive environmental regulations may lead to the phenomenon of "policy failure". Finally, the importance of rural environmental protection should be promoted. The government is recommended to maximize the function of traditional media such as newspapers, radio, and TV, as well as of new media such as the internet and social media, to strengthen the public awareness of the environmental hazards and health hazards of rural domestic sewage. This would be beneficial for effectively raising rural residents' environmental cognition and environmental protection awareness and thus increase rural residents' participation and WTP in environmental management. These recommendations are expected to provide references and insights for underdeveloped regions in China and other developing countries that are facing similar challenges.

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