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Can Internet Use Narrow the Gap between Farmers' Willingness and Behavior in Waste Classification? Empirical Evidence from Rural Areas in Jiangsu Province, China

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Abstract: Household waste classification and treatment are important for environmental protection and sustainable development. The Logit model is used to analyze differences in farmers' willingness and behavior regarding waste classification based on data from the China Land Economic Survey. Key findings include the following: (1) There is an evident discrepancy between waste classification willingness and action among rural residents. Despite nearly 90% of the sampled farmers expressing a willingness, nearly 40% do not practice waste classification. (2) Internet usage significantly reduces the discrepancy between farmers' willingness and actual waste classification practices. This observation is valid even after robustness checks and endogeneity discussions. (3) There is a partial mediating effect between ecological awareness and knowledge perception on farmers' willingness and behavior differences, which accounts for 12.9% and 52.6%, respectively, of the total impact. Notably, institutional limitations amplify the negative influence of Internet use on this discrepancy. (4) According to heterogeneity analysis, Internet use has a greater negative impact on farmers' willingness and behavior in waste classification in suburban villages and villages with environmental governance projects. This study proposes policy suggestions such as strengthening the construction of digital infrastructure in rural areas, enhancing the promotion and training of waste classification among farmers, and improving incentives and restraint mechanisms for rural household waste classification.

Keywords: internet; waste classification; deviation; willingness; behavior; logit model; environmental management

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1. Introduction

Classifying household garbage plays a crucial role in transforming lifestyles to be more eco-friendly [1], and is important for environmental protection and achieving sustainable development. Since 2004, China has been the world's largest producer of household garbage [2]. In recent years, the Chinese government is increasingly focused on issues around the classification of household garbage [3]. For rural China, the effective management of garbage is related to the livelihood and well-being of nearly 500 million farmers and influences the environmental improvement of over 90% of the land area. However, with increases in farmers' economic incomes, consumption levels rise, resulting in a sharp increase in rural China's garbage production [4]. Research has shown that rural China produces approximately 0.8 kg of household garbage per person per day [5], with an annual growth rate of 8% to 10% [6]. Based on the estimated rural population of around 498 million at the end of 2022, rural China produces 145 million tons of household garbage annually. Without such a vast amount of garbage being scientifically classified and resourcefully utilized, the ecological environment could face severe threats.

Theory and practice have shown that classified collection and treatment are effective ways to treat household garbage. Farmers are the main producers of rural household

garbage and the main executors of waste classification. Their willingness and behavior influence the effectiveness of household garbage management [7]. In the current research, scholars have addressed issues around rural household waste classification and governance from macro and microdimensions. (1) The effectiveness of waste management policies in different countries or regions have been studied, and scholars have compared the characteristics of different waste management models [8–10]. Other scholars have explored the impact of different macropolicies such as the institutional environment, reward and punishment measures, and promotional policies on waste classification [6,11,12]. For example, Zhang and Zhao [13] found that monitoring combined with reward and punishment systems can effectively promote residents' participation in waste classification. They also found that combining reward and punishment systems proves more effective. (2) Researchers have primarily studied residents' willingness, behaviors, and the influencing factors for household waste classification [14,15], along with potential strategies for improving household waste classification and governance [16,17]. In addition, some researchers have found that psychological factors such as environmental awareness, environmental skills, and group identity significantly influence residents' willingness and behavior toward waste classification [5,18,19].

Although the classification of household garbage is crucial, the actual implementation of relevant policies faces many challenges. In recent years, Chinese residents have shown improved environmental awareness. However, many lack the necessary knowledge and skills to classify garbage effectively, leading to a poor implementation of classification policies [20]. A particularly noteworthy phenomenon is that most Chinese residents have a willingness to classify garbage, but a considerable portion of them do not carry out waste classification in their daily lives. A survey of urban Chinese residents revealed that while 82.5% of participants expressed a willingness to classify garbage, only 13% did so [21]. Surveys targeting rural residents reported similar findings [22].

Studies indicate that Internet use influences the willingness and behavior of rural residents when it comes to waste classification [23]. China's digital expansion in rural areas has been rapidly growing, enhancing the online accessibility for farmers. This widespread Internet use has revolutionized farmers' information access, production methods, and lifestyle habits [24,25], reshaping their environmental awareness. Farmers can acquire garbage classification-related knowledge and learn classification-related skills through words, pictures, videos, and other means on the Internet, which can facilitate the implementation of garbage classification. Moreover, the Internet-embedded governance field can effectively provide technology empowerment and improve governance effectiveness, and has played a positive role in the implementation, supervision, publicity, and other processes of waste classification. The Internet brings efficient policy publicity, which is conducive to the formation of public awareness of environmental protection [26]. Current research primarily explores the impact of Internet use on farmers in areas like labor employment, agricultural production, and welfare levels [27–29]. However, as ecological and environmental concerns in rural areas grow, researchers are increasingly exploring how Internet use affects farmers' attitudes and actions towards waste classification [8,30]. For example, Liu et al. [31] found that using the Internet can positively influence farmers' willingness to classify garbage, though different Internet types on farmers' willingness to classify garbage is heterogeneous. Zhou et al. [32] and Xu et al. [22] also found that the use of the Internet has significantly improved farmers' willingness and action on waste classification.

Existing research has provided an important theoretical basis for this article, but there remain gaps in understanding. First, in the existing research on the willingness and behavior of household waste classification among farmers, most of the literature treats classification willingness and classification behavior as two distinct dependent variables, and emphasizes that willingness has a direct determining effect on behavior. However, only a few researchers have examined the deviation between farmers' willingness and behavior in waste classification as a separate dependent variable. Second, while some researchers

have confirmed the discrepancy between farmers' willingness and behavior in waste classification [33], they have not delved deeply into the mechanisms of this inconsistency. Furthermore, more evidence is needed to determine if, and how, Internet use influences farmers' attitudes and behaviors around waste classification [21]. Third, while some studies have considered how institutional constraints enhance farmers' willingness and behavior, the potential moderating effect of these constraints on the relationship between Internet use and the gap in farmers' willingness and behavior remains untested. Given these gaps, we draw from the China Land Economy Survey data and target farmers willing to classify household waste. We aim to determine whether Internet use can reduce the discrepancy between farmers' intent and actions concerning waste classification. Additionally, we evaluate the mediating roles of ecological awareness and knowledge perception and the moderating effects of institutional constraints. This study's findings help address certain limitations in the existing theoretical and empirical approaches.

2. Materials and Methods

Recently, China has rapidly developed its rural information infrastructure. The influx of information from the Internet inevitably influences farmers' production and lifestyles through mediums like education and publicity [29,34,35], simultaneously altering their views on ecological and environmental protection.

2.1. Internet Use and the Deviation between Farmers' Willingness and Behavior towards Waste Classification

The Theory of Planned Behavior (TPB) suggests that individual behavior is influenced by subjective attitudes, social norms, and perceived behavioral control [36]. An individual's willingness to act increases when they have a positive subjective attitude toward a particular behavior, as well as strong social norms and perceived control. Stern et al. [37]. introduced the Value Belief Norm (VBN) theoretical model, emphasizing that individual behavior results from a combination of external and subjective factors. According to the VBN theory, individual values can influence personal beliefs and thus affect individual behavior [38]. Guagnano et al. [39] proposed a similar perspective through the Attitudes–Behaviors–Conditions (A-B-C) theory, which suggests that residents' recycling behavior is influenced by both subjective attitudes and external conditions, with external conditions as a key factor in determining the execution of recycling behavior. According to this article, a combination of subjective and external factors determines individual behavior in classifying garbage.

From a subjective perspective, Internet use bolsters farmers' perception of environmental benefits, thereby enhancing their awareness of waste classification. Serving as a medium for information exchange and communication, the Internet exposes farmers to diverse content related to the ecological environment [26]. By conveying and disseminating the importance of environmental protection and the dangers of environmental degradation [28], the Internet amplifies farmers' commitment to waste classification. From one perspective, the Internet can play a positive guiding role. The Internet provides users with a large amount of ecological environmental protection information and publicizes the significance of waste classification for ecological environmental protection, human health, and sustainable development. The wealth of Internet data enlightens farmers about the importance of waste classification, promoting waste classification practice among farmers [31]. From another perspective, the Internet serves a cautionary purpose. By navigating the Internet, farmers can readily grasp the potential risks associated with household waste, fostering a stronger awareness of environmental urgency [40]. This awareness drives them to translate their willingness to classify garbage into tangible actions [41,42]. Evidently, Internet utilization amplifies farmers' awareness around environmental protection, thereby promoting waste classification.

From an external perspective, the use of the Internet serves as a valuable resource for enhancing farmers' knowledge and skills, thereby improving proficiency in waste classification. Firstly, the Internet reduces obstacles associated with information search,

acquisition, and sharing. This accessibility empowers farmers with essential knowledge and expertise about waste classification and recycling, like sorting techniques, recycling routes, and site locations [42]. This ease of access allows farmers to bypass challenges related to finances, time, energy, and geographical constraints when dealing with waste classification and management [43]. Secondly, the use of the Internet is also beneficial for expanding farmers' social networks, promoting the exchange of waste classification knowledge and skills among different farmers [7], thus refining their practical skills in the domain. Additionally, the Internet improves and standardizes waste classification practices. The Internet not only guides farmers in executing accurate garbage sorting [44] but also provides insights into tracking waste flows and understanding garbage resource utilization [43]. This standardized approach not only streamlines the waste classification and management process but also deepens farmers' comprehension and confidence in these methods. Evidently, the Internet furnishes farmers with a holistic grasp of the intricacies of waste classification, spurring them towards more efficient practices. Therefore, we propose the following hypotheses:

H1. *Internet use may reduce the deviation between farmers' willingness and behavior towards waste classification.*

H2. *Internet use may enhance farmers' ecological awareness, thereby reducing the deviation between their willingness and behavior in waste classification.*

H3. *Internet use may enhance farmers' knowledge perception, thereby reducing the deviation between their willingness and behavior in waste classification.*

2.2. The Moderating Role of Institutional Constraints

Waste classification is often characterized by administrative mobilization [45]. Therefore, participating in household waste classification is not solely an independent decision made by individuals after weighing various factors. It is also influenced by various social environments, with institutional constraints being a key component of this environment [21]. Specifically, the classification and governance of rural household garbage involves the macroinstitutional environment led by the government and the microinstitutional environment of village and community autonomy [12]. The government or community can strengthen supervision and constraints on farmers' environmental protection behavior by formulating a series of systems and rules, thereby increasing the implicit cost for farmers not engaging in waste classification [5]. Conversely, Internet use is influenced by institutional constraints as well, which moderate the deviation of farmers' willingness and behavior towards waste classification. In the macrocontext, where national efforts are pushing for rural environmental improvements, stringent institutional constraints encourage farmers to leverage the Internet. This enables them to stay informed about governmental and community-based waste classification policies and to acquire relevant skills, thus bolstering their practical competence in waste classification [31]. Additionally, as garbage sorting and disposal predominantly take place within village boundaries, and as villages continuously refine their internal regulations on waste classification, the Internet emerges as a potent tool for village leaders. They use it to advocate for and enforce waste classification and management rules [46], further aiding the transition of farmers' waste classification intent into actionable behavior. The following hypotheses are proposed based on this (Figure 1):

H4. *Institutional constraints may reduce the deviation between farmers' willingness and behavior in waste classification.*

H5. *Institutional constraints have a moderating effect on the path of Internet use on the deviation between farmers' willingness and behavior in waste classification.*

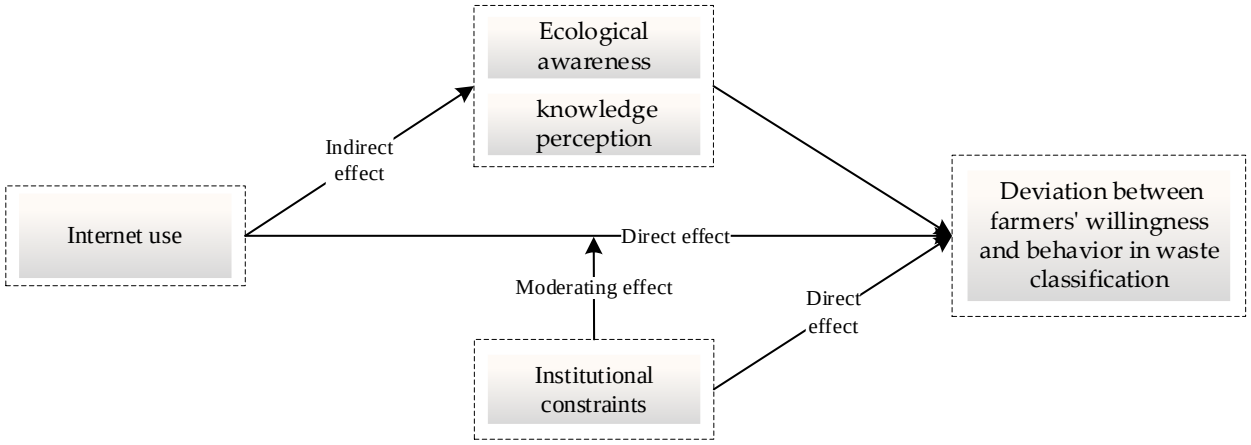

Figure 1. Theoretical mechanism diagram.

3. Data Description and Model Construction

3.1. Data

Data were sourced from the China Land Economic Survey (CLES), conducted by Nanjing Agricultural University in 2021. The survey used the Probability Proportional to Size (PPS) sampling technique, covering 48 villages in 13 prefecture-level cities in Jiangsu Province, and collected a total of 2420 household samples. Tailoring the dataset to fit this study's requirements, a refined sample size of 1933 households was chosen for the analysis. Jiangsu Province, as one of the most developed provinces in China's economy, is also far ahead in terms of network coverage. At present, the fiber optic network in Jiangsu Province will be 100% connected to households, and the 5G network signal coverage rate will reach 100%, achieving full coverage of rural network communication projects. Jiangsu Province not only has a good construction of rural Internet infrastructure, but also has a relatively sound waste classification policy system and a complete waste classification, transportation, and disposal system. Thus, the dataset employed in this article offers substantial representational validity.

3.2. Variables

3.2.1. Dependent Variable

The dependent variable of this article is the deviation between farmers' willingness and behavior in waste classification. Based on the previous analysis, we focus on how to reduce the deviation between farmers' willingness and behavior in waste classification; that is, how to achieve the transformation of farmers from having willingness without behavior to having willingness with behavior. Guided by the methodologies of Guo et al. [47] and Chang et al. [48], this study conceptualizes the disparity between farmers' intent and behavior in waste classification as instances where farmers exhibit a readiness to classify garbage but fail to manifest this intent into tangible action. Notably, we have excluded samples representing farmers devoid of any waste classification intent. The reason for excluding the sample of farmers who have no willingness of waste classification is because there is a clear evolutionary logic from willingness without behavior to willingness with behavior; that is, the core of transforming farmers' waste classification willingness into waste classification behavior is the expression of behavior. The primary issue for farmers with no intention of waste classification lies in cultivating willingness, and the reasoning logic is still moving from unintentional willingness to willingness. Upon an initial assessment of the dataset, it was observed that fewer than 10% of the farmers exhibited no waste classification intent. Consequently, excluding this subset from the analysis resulted in a minimal loss of sample representation. After removing the sample of farmers who have no intention of waste classification, farmers who have actively engaged in waste classification practices were assigned a '0', indicating a harmonious alignment between their intent and actions. In contrast, farmers who, despite their intent, refrained from actual

waste classification were designated a '1'. This code highlights a discord between their intent and subsequent behavior. Such a coding structure ensures a clear differentiation between farmers who translate their classification intent into action and those who do not, providing a comprehensive understanding of behavioral dynamics within the context of waste classification.

3.2.2. Key Explanatory Variable

The key explanatory variable of this paper is Internet use. Farmers who use computers, smartphones, or Internet cafes in their daily lives are categorized as Internet users, with a value of 1. Users who do not use the Internet will be assigned a value of 0.

3.2.3. Mediation Variable

The mediating variable of this article is farmers' cognition of waste classification, including ecological awareness and knowledge perception. Ecological awareness evaluates farmers' understanding of the importance of waste classification. Knowledge perception evaluates farmer's grasp of the skills of waste classification. It aims to measure their awareness of the potential repercussions unclassified waste might pose on the rural ecological landscape. Referring to existing research [22,28], we use two questions: (1) Do you think that the non-classification of household waste has a significant impact on the rural ecological environment? (2) Do you understand the relevant knowledge of household waste classification? To respectively characterize farmers' ecological awareness and knowledge perception of waste classification.

3.2.4. Moderation Variable

The chosen moderating variable for this study is institutional constraints. Drawing inspiration from the work of Song et al. [12], this study uses the following question: "Has the government established reward and punishment measures for rural household waste classification?" This question serves to characterize the presence and influence of institutional constraints. By incorporating this question, this study aims to gauge the level of governmental intervention and regulation in the area of rural waste classification and understand its potential impact on the behaviors and practices of farmers.

3.2.5. Control Variable

In previous studies, it has been shown that a farmer's willingness to protect the environment can be influenced by both the characteristics of the village where he lives, as well as his personal and family characteristics [49]. Therefore, this study controls the characteristics of the village where the respondents are located, and the individual and family characteristics of the respondents. The village attributes considered include its classification as a suburban village, the funds allocated for environmental activities, ongoing environmental governance initiatives, and the educational background of the village party secretary. The personal characteristics of the respondents include age, gender, whether they are village cadres, education level, and health status. The household characteristics of the respondents include the size of the household population and the annual household income. The definition and description of the variables are shown in Table 1.

Table 1. Description of variable assignment and descriptive statistics.

Categories	Variables	Variable Meaning and Assignment	Mean	S.D.
Dependent variable	Deviation	Having only willingness without behavior = 1; Having both willingness and behavior = 0	0.399	0.490
Independent variable	Internet use	Whether farmers use the Internet? Yes = 1; No = 0	0.484	0.500
Mediation variable	Ecological awareness	Do you agree that not classifying garbage has a significant negative impact on the ecological environment? Strongly disagree = 1; Strongly agree = 5	4.166	0.840
	Knowledge perception	Do you have any knowledge and skills related to waste classification? Never heard = 1; Well understood = 5	3.361	1.112
Moderation variable	Institutional constraints	Does the government establish reward and punishment measures for waste classification? Yes = 1; No = 0	0.295	0.456
Control variable	Suburban village	Is this village located in the suburbs of the city? Yes = 1; No = 0	0.412	0.492
	Environmental expenditure	The environmental governance expenditure of this village in the previous year (Unit: CNY 10,000)	59.328	87.643
	Environmental governance projects	Is there an environmental governance project in this village? Yes = 1; No = 0	0.304	0.460
	The education level of the village party secretary	Education years of the village party secretary (years)	13.331	2.651
	Gender of the respondents	What is the gender of the respondents? Male = 1; Female = 0	0.734	0.442
	Respondents' age	Age of the respondents (years)	61.430	11.380
	Cadre	Are the respondents village cadres? Yes = 1; No = 0	0.160	0.367
	Respondents' education level	Education years of the respondents (years)	7.422	3.941
	Health of the respondents	The health status of the respondents: Very poor = 1; Very good = 5	4.073	1.043
	Household population of the respondents	Unit: Person	3.109	1.604
	Annual household income	Unit: CNY 10,000	2.507	1.067

3.3. Model

3.3.1. Bivariate Logit Model

Considering that the dependent variable, "the deviation between farmers' willingness to classify garbage and their behavior", is a 0–1 discrete variable, a binary Logit model is used for the empirical testing. The model settings are as follows:

$$Deviation_i = \alpha_0 + \alpha_1 Internet_i + \alpha_2 Control_j + \mu_i \quad (1)$$

Among the variables, $Deviation_i$ indicates whether the willingness and behavior of the i-th farmer towards waste classification deviate; $Internet_i$ represents whether the i-th farmer uses the Internet; $Control_j$ is a series of control variables; μ_i is the random error term.

3.3.2. Mediating Effect Model

Referring to the classic testing program for mediating effects [50], we used the stepwise regression method to test the mediating effects of ecological awareness and knowledge perception. The specific estimation formula is as follows:

$$Deviation_i = \alpha_0 + \alpha_1 Internet_i + \alpha_2 Control_j + \mu_i \quad (2)$$

$$M_i = \mu_0 + \mu_1 Internet_i + \mu_2 Control_j + \mu_i' \quad (3)$$

$$Deviation_i = \varphi_0 + \varphi_1 Internet_i + \varphi_2 M_{it} + \varphi_3 Control_j + \mu_i'' \quad (4)$$

Equation (2) is the same as Equation (1). In Equation (3), M_i represents a mediation variable. Based on the significant coefficient of the key explanatory variable in Equation (2), the significance of the key explanatory variable in Equation (3) and the coefficient of the intermediate variable in Equation (4) are sequentially tested. If both are significant, then the intermediate effect exists. Meanwhile, if the coefficient of the core explanatory variable in Equation (4) is not significant, it indicates the existence of a complete mediating effect. If φ_1 is significant and φ_1 and $\mu_1 \times \varphi_2$ are the same sign, it indicates the existence of partial mediating effects; if the symbols are different, there is a masking effect.

3.3.3. Moderating Effect Model

We used a moderating effect model for testing and constructed the following regression model:

$$Deviation_i = \delta_0 + \delta_1 Internet_i + \delta_2 Mod_i + \delta_3 Internet_i \times Z_i + \delta_4 Control_j + \mu_i''' \quad (5)$$

In Equation (5), Mod_i represents the moderating variable "institutional constraints"; $Internet_i \times Mod_i$ represents the interaction term between institutional constraints and Internet use; δ_0 is a constant term; δ_1, δ_2, δ_3, and δ_4 are the coefficients to be estimated; μ_i''' is a random error term.

4. Empirical Analysis Results

4.1. Description of the Statistical Analysis

From the 2021 CLES samples, 2176 households, accounting for 89.9%, were willing to perform waste classification. Farmers from 237 households were unwilling to perform waste classification, accounting for 9.8%. There were also seven samples with missing values. According to the results, rural residents in Jiangsu Province have a high willingness to classify garbage. Based on the previous analysis, we only retained the samples of farmers with waste classification willingness, and the samples with missing or abnormal key variables were further excluded. Ultimately, 1933 farmers with waste classification willingness were retained. As shown in Figure 2, among these 1933 household samples, 1161 households (60.1%) implemented waste classification, and 39.9% of households showed a deviation in their willingness and behavior towards waste classification. This is consistent with the research findings of previous studies [3,22,51]. In terms of Internet use, 56.2% of the sample of farmers who expressed the willingness and behaviors of waste classification use the Internet. Among the sample of farmers who expressed willingness without behavior, only 36.5% use the Internet, which is significantly lower than the former. This suggests that Internet use may promote the conversion of farmers' willingness to classify garbage into waste classification behavior, thereby reducing the deviation between farmers' willingness to classify garbage and their behavior.

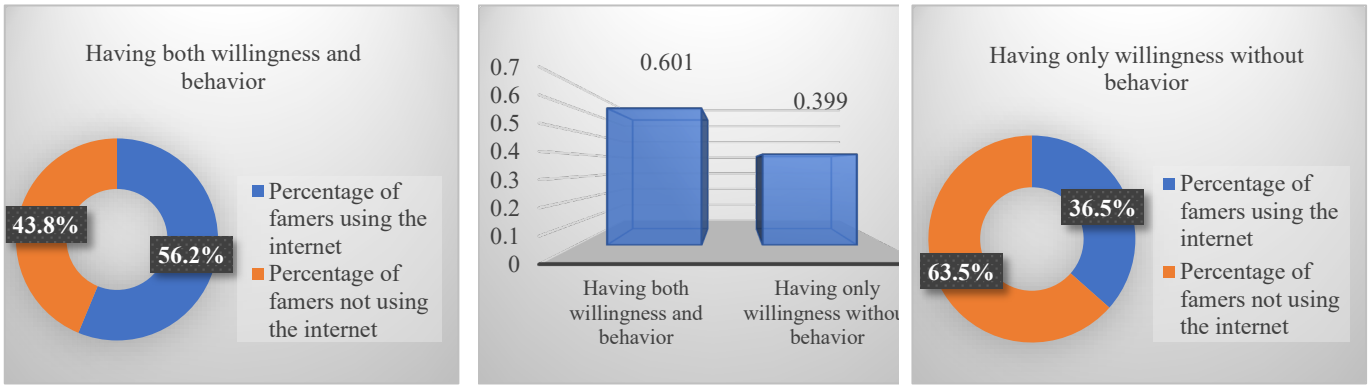

Figure 2. Survey results of farmers' willingness and behavior to classify garbage based on Internet use.

4.2. Analysis of the Influence of Internet Use on the Deviation between Farmers' Willingness and Behavior towards Waste Classification

In Table 2, the regression results for the binary Logit models and stepwise regression are shown. There is a significant negative impact of Internet use on farmers' willingness and behavioral deviation in waste classification, regardless of whether control variables are included. Taking columns (5) and (6) as examples, the regression coefficient for Internet usage is −0.492, which is significant at the 1% level. The marginal effect shows that for every 1 unit increase in Internet use, the probability of farmers' willingness to deviate from their behavior in waste classification decreases by 10.4%. Preliminary results show the validity of hypothesis H1.

Table 2. Impact estimation results.

Variable	Explained Variable: Deviation between Willingness and Behavior					
	Coefficient (1)	**Marginal Effect (2)**	**Coefficient (3)**	**Marginal Effect (4)**	**Coefficient (5)**	**Marginal Effect (6)**
Internet use	−0.804 ***	−0.185 ***	−0.770 ***	−0.167 ***	−0.492 ***	−0.104 ***
	(0.095)	(0.020)	(0.099)	(0.020)	(0.117)	(0.024)
Suburban village			−0.860 ***	−0.187 ***	−0.667 ***	−0.140 ***
			(0.107)	(0.022)	(0.123)	(0.026)
Environmental expenditure			−0.002 ***	−0.001 ***	−0.002 ***	−0.000 ***
			(0.000)	(0.000)	(0.000)	(0.000)
Environmental governance projects			−0.235 **	−0.051 **	−0.281 **	−0.059 **
			(0.113)	(0.025)	(0.116)	(0.024)
The education level of the village party secretary			−0.042 **	−0.009 **	−0.027	−0.006
			(0.020)	(0.004)	(0.020)	(0.004)
Gender of the respondents					−0.289 **	−0.061 **
					(0.118)	(0.025)
Respondents' age					0.020 ***	0.004 ***
					(0.006)	(0.001)
Cadre					−0.391 ***	−0.083 ***
					(0.149)	(0.031)
Respondents' education level					0.005	0.001
					(0.015)	(0.003)
Health of the respondents					−0.114 **	−0.024 **
					(0.051)	(0.010)
Household population of the respondents					−0.058 *	−0.012 *
					(0.032)	(0.006)
Annual household income					−0.137 **	−0.029 **
					(0.054)	(0.011)
Wald chi2	71.03 ***		178.34 ***		223.30 ***	
Pseudo-R2	0.028		0.073		0.093	
N	1933		1933		1933	

Note: Standard errors in parentheses; ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively.

According to the control variables, the results are consistent with Chen et al. [21] and Kang et al. [52]. Village characteristics like village type, environmental expenditure,

and environmental governance projects can significantly reduce farmers' willingness and behavioral deviation for waste classification. The education level of village party secretaries has a negative but not significant impact on farmers' willingness and behavioral deviation for waste classification. Respondents' age, health status, and service as village cadres can significantly reduce the deviation of farmers' willingness and behavior towards waste classification. The impact of respondents' education level is not significant. Gender difference has a significantly negative impact on the deviation between farmers' willingness and behavior towards waste classification. The possible reason is that waste classification is a problem-solving activity, and, compared to women, men often have a more adventurous spirit and problem-solving ability [26]. Therefore, it is likely that men are more willing to learn the relevant knowledge and skills of waste classification through the use of the Internet, and convert their willingness to behavior. Simultaneously, the age of the respondents can significantly reduce the deviation in their willingness and behavior towards waste classification. The possible reason is that implementing waste classification requires a certain amount of mental and physical energy to learn relevant knowledge and carry out relevant actions. For older farmers, it is more difficult and costly for them to accept waste classification knowledge and implement waste classification behavior.

4.3. Robustness Test

4.3.1. Replacing the Key Explanatory Variables

We replaced the key explanatory variable of "Internet use" to "Do you have a computer with Internet access in your home?". The regression results are shown in column (1) of Table 3, and the regression coefficient is significantly negative at the level of 1%. In addition, the marginal effect indicates that for every unit increase in the number of computers that households can access online, the probability of farmers' willingness to deviate from their behavior in waste classification decreases by 5.3%.

Table 3. Results of the robustness test.

Variable	Explained Variable: Deviation between Willingness and Behavior					
	Coef. (1)	**Mgn. (2)**	**Coef(Probit) (3)**	**Mgn(Probit) (4)**	**Coef. (5)**	**Mgn. (6)**
Computer with Internet access	−0.253 ***	−0.053 ***				
	(0.076)	(0.016)				
Internet use			−0.308 ***	−0.107 ***	−0.464 ***	−0.101 ***
			(0.071)	(0.024)	(0.124)	(0.027)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Wald chi2	165.03 ***		240.25 ***		171.56 ***	
Pseudo-R2	0.088		0.093		0.082	
N	1933		1933		1623	

Note: Standard errors in parentheses; *** indicates significance level of 1%.

4.3.2. Replacing the Regression Model

Compared to the Logit model, the Probit model assumes a stricter probability distribution. Therefore, we used the binary Probit model for retesting, and the regression results are shown in columns (3) and (4) of Table 3. Both the regression coefficient and marginal effect are significantly negative at the 1% level, indicating that Internet use can significantly reduce the discrepancy between farmers' willingness and behavior to classify garbage. The regression results of the two models are consistent.

4.3.3. Subsample Regression

Village cadres are the main implementers of the government's waste classification policy and are responsible for village environmental governance. Thus, they are more likely to carry out waste classification in their daily lives. Therefore, we conducted a retest after excluding the sample of village cadres as the respondents. The regression results are shown

in columns (5) and (6) of Table 3, and the impact of Internet use on farmers' willingness and behavior to classify garbage is still significantly negative. Therefore, hypothesis H1 has been further validated.

4.4. Endogeneity Test

Endogeneity issues may arise from various sources, potentially distorting the relationship between variables in a study. In this context, although there is no apparent reverse causation between Internet use and farmers' attitudes and actions regarding waste classification, it is essential to address possible endogeneity concerns. To mitigate these concerns, we employ the instrumental variable method, a powerful technique that can help offer more consistent estimations in the presence of endogeneity. According to Xu et al. [22] and Deng et al. [53], we selected the proportion of rural households using the Internet in villages as the instrumental variable. There are two reasons: (1) A village with a high proportion of Internet users shows that, in such an environment, individuals are surrounded by Internet peers. This prevalence often creates a group effect, encouraging others in the vicinity to also adopt Internet usage, ensuring the relevance of the instrument [54]. (2) The chosen instrumental variable is a village-level indicator, which will not directly influence the willingness and action of rural households to classify garbage. This ensures the instrument's exogeneity, meaning that it will not be correlated with the error term in the regression. Incorporating the percentage of Internet-using rural households within villages as an instrumental variable can, in theory, counteract biases stemming from endogeneity, providing more accurate and reliable findings.

To test the endogeneity, the IV Probit model was utilized. Comparisons have shown consistency between the Probit and Logit model conclusions. In the first stage, the endogenous variable (Internet use) was regressed on the instrumental variable (proportion of village Internet usage), yielding predicted values. Results, presented in column (1) of Table 4, show a significant positive impact of village Internet usage proportion on farmers' Internet use. The F-value is 62.32, and *p*-values for the Wald endogeneity test and AR test are both below 0.01, indicating no weak instrumental variable problem. In the second stage, the IV Probit method was applied to regress the dependent variable (difference in willingness and behavior) on the fitted values from the first stage. Column (2) of Table 4 displays the results, maintaining a significant negative association at the 1% level, even after addressing potential endogeneity. These findings reinforce the initial conclusions, supporting hypothesis H1.

Table 4. Findings from the endogeneity examination.

Variable	Internet Use		Deviation	
	Coef. (1)	Std. Err. (2)	Coef. (3)	Std. Err. (4)
Internet use rate	0.440 ***	0.079		
Internet use			−1.776 ***	0626
Control variables	Yes		Yes	
Wald chi2			178.96 ***	
The first-stage F-value	62.32 ***			
Wald test			9.76 ***	
Weak IV AR test			8.04 ***	
Adj R2	0.280			
N	1933		1933	

Note: Standard errors in parentheses; *** indicates significance level of 1%.

4.5. Mechanism Analysis

4.5.1. The Mediating Role of Ecological Awareness and Knowledge Perception

To further understand the underlying mechanisms driving this relationship, this study delved into the potential mediating roles of ecological awareness and knowledge perception.

Table 5 displays the results derived from the stepwise regression analyses. According to column (1), Internet use can significantly and positively affect farmers' ecological awareness of waste classification. This implies that Internet use can significantly reduce the deviation between farmers' willingness and behavior to classify garbage, and ecological awareness can also significantly reduce the deviation between farmers' willingness and behavior to classify garbage. Therefore, ecological awareness plays a partial mediating role in the impact of Internet use on farmers' willingness and behavior deviation towards waste classification. Further calculations indicate that the mediating effect of ecological awareness accounts for 12.9% of the total effect. Similarly, as shown in columns (3) and (4), knowledge perception also has a partial mediating effect. The mediating effect of knowledge perception accounts for 52.6% of the total effect. At this point, H2 and H3 have been validated.

Table 5. Mediation effect analysis.

Variable	Internet Use→Ecological Awareness→Deviation		Internet Use→Knowledge Perception→Deviation	
	Ecological Awareness (1)	Deviation (2)	Knowledge Perception (3)	Deviation (4)
Internet use	0.332 *** (0.101)	−0.452 *** (0.118)	0.342 *** (0.096)	−0.396 *** (0.122)
Ecological awareness		−0.157 *** (0.060)		
Knowledge perception				−0.756 *** (0.057)
Control variables	Yes	Yes	Yes	Yes
Wald chi2	103.90 ***	228.28 ***	437.68 ***	325.58 ***
Pseudo-R2	0.024	0.096	0.080	0.175
N	1933	1933	1933	1933

Note: Standard errors in parentheses; *** indicates significance level of 1%.

4.5.2. The Moderating Effect of Institutional Constraints

Earlier theoretical discussion suggested that institutional constraints might play a dual role concerning the deviation of farmers' willingness and behavior towards waste classification. These constraints might not only exert a direct influence but might also modulate the extent to which Internet use affects this deviation. Table 6 elucidates these dynamics. Columns (1) and (2) show that institutional constraints have a significant negative impact on the deviation of farmers' willingness and behavior towards waste classification. Column (3) shows that the interaction coefficient between institutional constraints and Internet use is significantly negative at the 10% level. Also, the interaction coefficient is consistent with the coefficient sign of the key explanatory variable in the benchmark regression results; the impact of Internet use on farmers' willingness and behavior deviation in waste classification is moderated by institutional constraints. Therefore, the hypotheses H4 and H5 were validated.

Table 6. Analysis of regulatory effects.

Variables	Explained Variable: Deviation between Willingness and Behavior		
	(1)	(2)	(3)
Internet use		−0.497 ***	−0.413 ***
		(0.120)	(0.130)
Institutional constraints	−1.288 ***	−1.287 ***	−1.088 ***
	(0.131)	(0.131)	(0.175)
Internet use × Institutional constraints			−0.457 *
			(0.266)
Control variables	Yes	Yes	Yes
Wald chi2	264.37 ***	288.55 ***	274.80 ***
Pseudo-R2	0.127	0.134	0.136
N	1902	1902	1902

Note: Standard errors in parentheses; ***, and * indicate significance levels of 1%, and 10%, respectively.

4.6. Heterogeneity Analysis

From the perspective of village types, as shown in columns (1) and (2) of Table 7, compared to ordinary suburban villages, the negative impact of Internet use in suburban villages is more significant. The possible reason is that the construction of waste classification infrastructure in suburban villages is relatively complete, making it more convenient for farmers to carry out waste classification. An equally enlightening trend is observed when considering the presence or absence of environmental governance projects in the villages. As shown in columns (3) and (4) of Table 7, villages with established environmental governance projects witness a stronger positive influence of Internet use than in villages without such projects. The underlying rationale for this could be the structured, often obligatory nature of these governance projects. Since these initiatives are typically orchestrated by governmental bodies, they possess a certain authoritative weight, pushing residents to act in line with their waste classification intentions.

Table 7. Heterogeneity analysis under different dimensions.

Variables	Explained Variable: Deviation between Willingness and Behavior			
	Suburban Village (1)	Non-Suburban Villages (2)	With Project (3)	No Project (4)
Internet use	−0.740 ***	−0.380 ***	−0.587 **	−0.467 ***
	(0.203)	(0.146)	(0.241)	(0.136)
Control variables	Yes	Yes	Yes	Yes
Wald chi2	99.47 ***	90.40 ***	111.03 ***	135.39 ***
Pseudo-R2	0.111	0.061	0.159	0.076
N	797	1136	588	1345

Note: Standard errors in parentheses; ***, and ** indicate significance levels of 1%, and 5%, respectively.

5. Conclusions and Recommendations

In recent years, with a heightened global focus on ecological preservation, the management and categorization of household waste has gained traction as a critical academic and practical concern. This study, anchored in data from the 2021 China Land Economy Survey, offers a deep dive into how Internet usage can shape the alignment between farmers' willingness and behavior regarding waste classification in rural China and analyzes the mechanisms of ecological awareness, knowledge perception, and institutional constraints in this impact path. The results indicate the following: (1) In rural China, there is a significant deviation between farmers' willingness and behavior to classify waste. Survey data show that, although nearly 90% of the sample farmers are willing to carry out waste classification, nearly 40% of the farmers who are willing to carry out waste classification have not implemented waste classification behavior. (2) The use of the Internet has a

significant negative impact on the deviation between farmers' willingness and behavior towards waste classification. In other words, the use of the Internet can convert farmers' willingness to waste classification into waste classification behavior. From the perspective of marginal effects, for every increase in Internet use of 1 unit, the probability of farmers' willingness to deviate from their behavior in waste classification will decrease by 10.4%. (3) Mechanism analysis shows that ecological awareness and knowledge perception play a partial mediating role in the impact path of Internet use on the deviation of farmers' willingness and behavior towards waste classification. Specifically, the mediating effects of ecological awareness and knowledge perception account for 12.9% and 52.6% of the total effects, respectively. (4) Further analysis reveals that institutional constraints can not only directly and negatively affect the deviation of farmers' willingness and behavior towards waste classification, but also have a positive moderating effect on the impact path of Internet use on the deviation of farmers' willingness and behavior towards waste classification. The negative effects of Internet use on farmers' willingness and behavior towards waste classification are exacerbated by institutional constraints. (5) A heterogeneity analysis found greater negative impacts of Internet use on farmers' willingness and behavior in waste classification in suburban villages and villages with environmental governance projects.

Based on this study's findings, it is evident that to address the discrepancy between farmers' willingness and behavior regarding waste management in rural China, comprehensive policy measures are required. We suggest the following: (1) Strengthen the construction of rural Internet infrastructure. We need to accelerate the construction of the rural network infrastructure, increase the penetration rate of rural Internet, and provide good conditions for ensuring that farmers use digital tools. Accelerate the development of the Internet and digital platforms for rural residential environment improvement, give attention to digital technology in the classified treatment of rural household garbage, and improve the efficiency of rural household garbage treatment. (2) Strengthen waste classification policies and knowledge dissemination. Online media should appropriately strengthen publicity and education on environmental protection and waste classification so that farmers can understand the importance of household waste classification and treatment through the Internet, and thereby enhance their awareness of environmental responsibility. At the same time, diversified waste classification knowledge and skills training should be provided to farmers through the Internet to improve their practical ability in waste classification. (3) Formulate and implement reward and punishment measures for waste classification. The government should continue to improve the household waste classification system and policy system, improve the constraint and incentive mechanism for household waste classification, and actively create a good atmosphere for everyone to participate. Village cadres should pay more attention to the classification and management of rural household waste, improve the reward and punishment rules for village waste classification by revising village regulations and implementing point system management, and promote the conversion of farmers' willingness to classify garbage into waste classification behavior. (4) Reasonably arrange garbage sorting and collection stations to effectively promote easy and convenient sorting services. Rural communities need to combine the characteristics of village population size, agricultural production, and daily life, as well as the amount and composition of household waste generated to set corresponding garbage classification and recycling standards and collection time plans for different types of waste, and to set up appropriate and easily identifiable garbage collection stations. Moreover, when planning the geographical distribution of garbage collection sites in a reasonable manner, special attention should be paid to the spatial distribution characteristics of rural residential areas in order to reduce the time and energy consumption of rural residents for household waste classification and recycling, enhance the convenience of garbage classification services, and truly achieve the reduction, resource utilization, and harmless treatment of rural household waste.

While offering valuable insights into the relationship between Internet use and farmers' behaviors, there are certain limitations. The binary distinction of farmers either using or

not using the Internet might oversimplify the reality. Variations in Internet usage, such as frequency, purpose, or the nature of content consumed, might all influence farmers' behaviors differently. Some might use the Internet primarily for entertainment, while others might engage in educational or agricultural forums, which could provide varying levels of exposure to waste management practices. Moreover, this study's focus on farmers already inclined to classify waste potentially overlooks a significant portion of the population. Those farmers without an initial willingness to classify garbage represent a crucial demographic to study, as they might need different interventions or strategies to shift their mindset. Convincing this group might present unique challenges, and understanding the barriers to their engagement could be instrumental in devising more comprehensive waste management strategies. Future research might benefit from a more nuanced understanding of farmers' Internet use and from expanding this study's scope to include those without an initial inclination towards waste classification.

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