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Domestic Garbage Classification and Incentive-Based Policies in China: An Empirical Analysis

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Abstract: In recent decades, with the rising living standards of rural China, the amount and volume of household waste has increased continuously, causing serious environmental and human health risks. Effective garbage classification reduces garbage volume, decreases the difficulty of garbage disposal, and facilitates the recycling of resources, thereby improving environmental quality. Domestic garbage classification (DGC) has been practiced frequently in developed countries and is now at a relatively mature stage. There is no robust model for garbage classification available globally as of yet, and each country has its policy frameworks to reduce, recycle, and reuse (3R) garbage. Little attention has been paid to knowing whether and to what extent incentive-based policies called "rewards and punishments" improve garbage classification and further help achieve targets of sustainable development goals (SDGs). Recently, developing countries, like China, have begun to incorporate DGC into their laws and promote enforcement measures in a few cities. However, empirical studies on residents' willingness to accept DGC punishments and rewards are still relatively scarce and a hot topic of global scientific discussion. To enrich the knowledge, this study collected datasets from 9983 valid questionnaires from east China (16 selected independent variables), and analyzed the key factors affecting residents' acceptance of punishments and rewards, employing logit models. The results found that the level of education plays an important role for residents that are more inclined to accept DGC rewards and punishments. Moreover, farmers were insensitive to DGC rewards but very sensitive and unsupportive of punishments, and the hardware facilities of the quarter had a greater impact on residents' willingness to accept DGC rewards and punishments. Findings recommend that rewards be the main focus and punishments be supplemented, thus the incentive-based policies should be improved through law enforcement and implementation of robust policy frameworks in order to promote residents' acceptance of rewards and punishments and to accelerate better garbage classification.

Keywords: domestic garbage classification; reward and punishment; waste management; logit model; environmental quality

1. Introduction

Garbage classification and reduction is imperious in developing countries (e.g., India, China, Pakistan, and Bangladesh), where the imbalance between the rapid increase in the disposal of solid waste and insufficient waste capacity could be challenging and a matter of scientific discussion [1]. Effective garbage classification can lower carbon emissions during the transportation and treatment of garbage, as well as reduce atmospheric greenhouse gas emissions from the fermentation, and decay of garbage, ease the difficulty of garbage disposal, and facilitate the recycling of waste. In general, improper garbage

disposal has resulted in several environmental and human health problems [2–6]: (i) air pollution, (ii) water pollution, (iii) soil contamination, (iv) potential threats to food safety and quality, (v) pathogenic transmission of diseases, and (vi) compromising the cleanliness and sanitation of rural residents and societies. Since the late 1970s, some developed countries such as Japan, Germany, the United States, and Singapore have already implemented domestic garbage classification (DGC) and collection, and their per capita amount of domestic garbage discharged is far lower than that of developing countries [7]. One of the important reasons for this is the efficient use of technologies for garbage classification followed by effective management and recycling of garbage [8]. Since 2000, the amount of rural solid waste in China has been increasing rapidly and largely under the radar: it has grown from 46,700 million tons (Mt) in 2013 to 52,200 Mt in 2019 [9]. Subsequently, around 30–60% of rural garbage was mismanaged, leading to environmental degradation and economic losses [10]. However, garbage classification has only been gradually implemented in China and the non-compulsory approach of "government-led, publicity and education-oriented" has been adopted, with little effect on the whole. The Ministry of Housing and Construction, the Ministry of Environmental Protection, and other departments, as well as local provincial governments at all levels in China, have issued specific guidance methods and supporting policies to upgrade the garbage classification system. In general, garbage classification in China entails separating the garbage into four predefined categories (recyclables, hazardous waste, food waste, and other garbage), followed by packaging, transporting, and processing garbage efficiently for various byproducts or dumping at landfill sites [11,12]. Recently, garbage classification has gradually shifted to a model of "government guidance, market-oriented operation, and participation of residents" to promote the substantive progress of garbage classification in China [10,13].

According to the government's plan, by the end of 2020, China should be able to establish a system of laws and standards related to garbage classification, form a duplicable and scalable model of DGC, and achieve a recycling rate of over 35% in the cities where mandatory garbage classification is implemented [14]. So far, the national work of DGC is still in the initial stage, and many problems exist in the areas of the implementation of the main responsibilities of cities, the formation of public habits, the construction and upgrading of classification facilities, and improvement of support policies [15]. As seen in Shanghai and other advanced cities, garbage classification in China has begun to bear fruit, but the implementation is weak nationwide. The policies of the pilot cities are representative. However, the model, which relies on substantial human, material, and financial inputs, is not nationally universal because not all cities are as developed as these pilot cities and have sufficient funds and workforce [7,16].

Generally, the classification and disposal of domestic garbage is a systematic program that requires the concerted efforts of all parties and the precise application of policies. The success of DGC can occur from clear guidelines and simple processes for what can or cannot be recycled; thus, rewards and punishments for residents are necessary incentives and monitoring tools to promote effective DGC, not an end in itself. The credit-linked motivation mechanism some cities try to establish is in line with the spirit of the municipal government's policy and is a step ahead of the current policy. Many of Chinese cities have written the rewards and punishments of DGC into law. Beijing was the first Chinese city to legislate DGC, and over 40 cities such as Shanghai, Taiyuan, Changchun, Hangzhou, Guangzhou, Yichun, Ningbo and Yinchuan have successively formulated regulations on the management of DGC, incorporating garbage classification into a legal framework. In these laws, individuals can be fined from 20 to 1000 CNY for illegal garbage disposal. According to the laws of these cities, units, households, and individuals generating domestic garbage should fulfil their obligations of domestic garbage reduction at the source, garbage classification, and disposal. It is unlawful for individuals to dump, scatter, pile up or burn domestic garbage at will. Units can be fined up to 50,000 CNY for mixing garbage and transportation; this refers to the garbage remover, either hired by the property or a professional team from the sanitation department. The garbage remover cannot mix different categories

of garbage together and pull them away in one truck, otherwise, it will be penalized. With the addition of legislation and clear administrative penalties, the mandatory nature of the garbage classification system has been significantly increased. However, before doing so, it is necessary to ask the following questions: How willing residents are to accept rewards and punishment during phase I of the project? How effective is the implementation of the current reward and punishment rules? Do the reward and punishment rules affect the willingness and effectiveness of residents in DGC? What more scientific, reasonable, and practical reward and punishment rules should be formulated and implemented to promote DGC? Will residents accept some cities' plans to record the non-compliant disposal of domestic garbage on people's civility credit file?

To answer the above questions, empirical analysis of the logit model has been employed on 9983 questionnaire data in east China. This study analyzes the influencing factors on the willingness of residents to accept reward and punishment measures of DGC. Additionally, corresponding planning and adjustment suggestions have been proposed for the long-term, effective, and efficient implementation of future DGC reward and punishment mechanisms. The results from such a large sample size are also instructive for more effective garbage classification and could be established in other provinces of China and developing countries as well.

2. Literature Review

There are two main perspectives on the interpretation of environmental behavior in the social sciences. The first mainly emphasizes the starting point of the main body of the actor, and believes that environmental choice behavior is the "active choice" of the actor. The second advocates an external social structure approach, in which the external environment constrains human beings, and actors make "passive choices" [17]. As far as DGC is concerned, it is mainly the individual's internal choice and external contextual factors that influence residents' behavior [16,17].

Garbage classification is a complex process [18,19], which is affected by numerous factors, including existing policy [20,21], and social environment factors [22,23] at the macro level, as well as individual resident factors at the micro level, such as values [24,25] and knowledge of garbage classification [26]. Generally, accessibility to garbage classification and policy effectiveness promote the willingness to participate in classification. Bai and Lin [27] observed that those who know more about urban classification are more likely to participate in garbage classification. Perceived behavior control is an important factor in the psychological level of residents, i.e., the residents' perception of the convenience, realism, feasibility, and operability of implementing a certain behavior. Also, study shows that convenient environmental facilities and services are most effective in promoting residents' participation in household garbage classification and recycling behavior [28]. Notably, DGC requires a certain amount of time and supporting equipment, so whether residents have the time and energy to classify garbage and whether it is convenient for them to put garbage out will have a certain impact on residents' participation [8]. Garbage classification is not an isolated public service, a new approach called polycentric waste governance (PWG) was put forward to involve a broader range of stakeholders in managing the growing waste. Some research identifies the impediments to the implementation of the garbage classification policy in China through a stakeholder theory framework; these impediments include ambiguous management at the upper echelons of government, bias in policy enforcement at the junior levels of government, opposition from incineration enterprises, and the weakness of resource recyclers and non-governmental organizations [29].

Regarding rewards and punishments for garbage classification, Wertz [30] first explored the issue of residential garbage recycling. Scholars such as Jenkins, Fullerton, and Kinnaman, Linderhof et al., Dijkgraaf and Gradus, and Callan and Thomas have further expanded Wertz's research, which revealed that market orientation, unit pricing, and variable-rate pricing have a direct and significant effect on the effectiveness of garbage classification [18,31–34]. Iyer and Kashyap further argued for the timeliness of

reward policies, suggesting that the effects of a policy disappear as the policy ends [35]. Subsequently, more studies have explored the influence of government and policies on garbage classification and recycling, such as garbage management policies [36,37], laws and regulations [20,38], the government's investment in garbage classification and recycling hardware facilities [39,40], and the relevant departments' investment in educating residents on garbage classification [12,26,41,42]. Callan and Thomas [18] found that adopting certain incentives and penalties directly and significantly impacts residents' garbage classification and recycling. Yang et al. [43] analyzed the garbage classification awareness and behavior of college students in typical colleges and universities in Nanjing. They concluded that institutional punishment has a direct positive effect on college students' garbage classification awareness and behavior, while economic rewards show reciprocal results due to the limitation of the audience's scope and the implementation's unsustainability [43].

Nowadays, the search for rewards on DGC mainly focuses on the robust policy implications for garbage management and recommendations on garbage recycling and reduction, intending to create a deposit system or a point system and a system of payment by consumers. Fullerton Don and Tom Kinnaman [32] examined the impact of a quantity-based charging policy on residential waste emissions. Reschovsky and Stone [44] used empirical analyses to prove that when the government's garbage classification policy is combined with the market adjustment mechanism, it is more influential the residents' participation in garbage classification. Zhan and Zhang [45] analyzed the total economic value of urban residents' garbage classification, recycling, and reduction management and the factors affecting the willingness to pay, providing a reference basis for government and social investment. Xie and Peng [46] proposed that the general public, as natural persons, can demonstrate higher quality and sustained higher prestige among their neighbors, classmates, and other groups and that these qualities and prestige work together to form incentives that can additionally make residents carry out garbage classification and recycling at lower costs.

Previous studies have explored the various factors affecting the effectiveness of residential garbage classification, i.e., macro-level government policy factors, socio-cultural environment factors, and micro-level psychological factors of individual actors [42]. Recent studies have also focused on analyzing individual behavior at the micro level, and the research methodology has become increasingly prosperous. However, on the one hand, these factors are still relatively discrete and lack a comprehensive, multilevel framework for analyzing influencing factors. At the same time, the analytical framework needs to be localized. On the other hand, micro-level studies have focused on willingness to sort and recycle, but willingness does not equate to actual sorting and recycling results. The literature has not yet constructed a bridge between willingness and actual results. Even more unfortunate is that most higher-level studies have been conducted primarily on developed countries or regions. Research at the micro level is upgrading and promoting garbage minimization and recycling in developing countries like China and ensuring that garbage classification and recycling policies accepted by residents will help in the efficient management of waste and further achieve the target of sustainable development goals (SDGs-11, 12, 14).

Research on garbage classification in Chinese academia has focused on the governance model of DGC, the participation of subjects in DGC, the local effectiveness of DGC, and the exploration of the causes affecting DGC. Existing studies lack both theoretical frameworks and large-sample empirical studies. In terms of punishment and reward for garbage classification, urban practice in China is currently in its infancy, and academic research results are yet to be enriched. Based on the discussion mentioned earlier, this study analyzes the influencing factors of residents' willingness to accept DGC rewards and punishments through a large number of sample data, which supplement the existing results and can also play a pivotal role in future policy adjustment and practical application.

3. Materials and Methods

3.1. Study Site

Ningbo (29.8683° N, 121.5440° E; 9816 Km^2) was the first Chinese city to use a World Bank loan to implement the DGC program and build a recycling system for urban areas; the cooperation with the World Bank has put Ningbo at the forefront of DGC in China. From September 2013 to July 2020, 905,000 households in Ningbo participated in garbage classification during the program's first phase. A complete DGC system of sorting, collection, transportation, and disposal has been set up; a comprehensive, full-coverage management system has been established with each administrative district, street, community, and quarter residents as the main body at all levels. Additionally, a preliminary design of assessment and reward and garbage traceability has been formed, with the two-dimensional code mechanism.

The first phase of the project in Ningbo has already built a complete domestic garbage classification transfer and terminal disposal facility, but there is a large gap between the proportion of accurately placed domestic garbage at the source and that of advanced cities such as Shanghai and Xiamen. Measures such as "supervision at the barrel" and "secondary sorting", which are currently being adopted by the quarters to improve the quality of garbage classification in the short term, are costly, labor-intensive, and unsustainable. The reward system designed in the project's first phase is based on the quality of garbage and the QR code information on the food waste bags, which enables the traceability of the source of domestic garbage disposal and the precise guidance of householders on garbage classification. However, factors such as the long management chain and human interference in the waste traceability process affected the effectiveness of the assessment and rewards. In response to the current problems, the second phase of the World Bank program on garbage classification in Ningbo will further focus on result-based rewards. One of the program designs is to tie the evaluation of DGC quality and quantity to personal credit, forming an ecosystem in which residents' credit and individual garbage classification behaviors influence and constrain each other.

In parallel with the World Bank project, the Ningbo government has enacted policies for rewards and punishments for garbage classification into the existing law. According to the regulations on the management of DGC in Ningbo City which came into effect on 1 October 2019, "the government and relevant departments shall form a corresponding incentive mechanism for DGC, support village/neighborhood committees to mobilize people's motivation through gift redemption and material rewards; and reward units and individuals who have outstanding achievements in DBC work" (Article 43). However, punishments for offences such as failing to classify domestic garbage were provided for, mainly in the form of fines. For example, Article 50 of the regulation stipulated that, "Individuals and units who fail in garbage classification shall be ordered to make corrections by the Urban Sanitation Authority. If they refuse to make corrections, individuals shall be fined 20–200 CNY, and in serious cases 200–500 CNY; units shall be fined 500–5000 CNY". Nevertheless, "offenders may apply voluntarily to the urban sanitation authority to participate in social services related to DGC work to reduce or avoid administrative punishments" (Article 51). There is a gap between the punishment rules and their actual implementation. In reality, residents who do not comply with the rules of DGC usually do not receive administrative punishment, most of them have been assisted in correcting their garbage classification by the quarter's cleaners and other relevant personnel when they put it in the garbage cans. Moreover, if residents litter in the quarter, the costs to the property owner of tracking down the source are far greater than the fines imposed on those who started the problem, so it is often difficult to pursue the case.

3.2. Data and Descriptive Statistics

The willingness to accept the reward and punishment for DGC analyzed in this study is a binary discrete choice problem, i.e., there are only two choices for the dependent variable of "willingness" and "unwillingness", so a binary choice model needs to be constructed.

There are three commonly used probabilistic selection models: the linear probability model (LPM), the probit model, and the logit model.

The dependent variable of the LPM Model is a continuous variable, while the dependent variable of the "willingness of acceptance" selection problem studied in this paper is a discrete variable with values of "0–1", which is inconsistent with the assumptions of the LMP model, and therefore the LPM model cannot be adopted. For the "0–1" binary discrete model, the logit model and the probit model are more commonly used. The limitation of the probit model is that it requires that the unobservable parts of all utilities obey the normal distribution. In many cases, the unobservable variables do not obey the normal distribution. This is the case in this paper, so it is not appropriate to use a probit model.

The logit model is the most widely used in dealing with binary choice problems with fewer constraints. This model can predict the impact relationship between discrete dependent variables and a set of explanatory variables, screening out factors with significant effects. Therefore, a logit model is used for modeling and analysis when studying the problem of residents' willingness to accept the reward and punishment for DGC.

Combining the strengths of existing studies [42], this research intends to select 16 attribute features, including residents' characteristics (gender, age, education level, occupation, identity, number of family members) and external environment/hardware facilities (elevator equipment situation in residence buildings, uniformly clearing and delivery of garbage in residential area, equipment situation of DGC facilities in residential area, and property management configuration), to find out the influencing factors of residents' willingness to accept reward and punishment measures for DGC in east China. The definition and explanation of explained variables and explanatory variables in this research have been discussed in Table 1.

Table 1. Variable definitions and explanation.

Variable	Abbr.	Definition	Explanation (Unit)
Y_1	REW	Residents' willingness to accept reward measures for garbage classification	N = 0; Y = 1
Y_2	PUN	Residents' willingness to accept punishment measures for garbage classification	N = 0; Y = 1
X_1	SEX	Gender	M = 0; F = 1
X_2	AGE	Age	<18: 1; ≥18, <35: 2; ≥35, <60: 3; ≥60: 4
X_3	EDU	Education level	Junior high school and below = 1; High school or technical secondary school = 2; junior college = 3; Bachelor's degree or above = 4
X_4	JOB1	Farmer	N = 0; Y = 1
X_5	JOB2	Enterprise employees	N = 0; Y = 1
X_6	JOB3	Freelance	N = 0; Y = 1
X_7	JOB4	Government agencies and institutional organizations' employees	N = 0; Y = 1
X_8	JOB5	Retirees	N = 0; Y = 1
X_9	IDN1	The staff of property management	N = 0; Y = 1
X_{10}	IDN2	The staff of the community, sub-district office, or residential area	N = 0; Y = 1
X_{11}	IDN3	Cleaning staff	N = 0; Y = 1
X_{12}	HOM	Number of family members	Person
X_{13}	ELE	Elevator equipment situation in residence buildings	N = 0; Y = 1
X_{14}	TRAN	Whether garbage classification and disposal in residential areas are uniformly delivered and transported	N = 0; Y = 1
X_{15}	FAC	Whether residential garbage classification facilities are adequately equipped	N = 0; Y = 1
X_{16}	PROP	Residential property management configuration	N = 0; Y = 1

Residents' identity attributes, including gender, age, education level, occupation, identity, and number of family members (X_1–X_{12}), may have impacts on their willingness to accept rewards and punishment on DGC. Among the identity attributes of the residents, the closer their job content is to the terminal of DGC, the lower their willingness to accept DGC rewards and punishments.

The residents' living area's environmental attributes may significantly impact the willingness to accept rewards and punishment measures of garbage classification. The higher the external environment/hardware facilities (X_{13}–X_{16}) attributes, the residents may be more willing to accept DGC rewards and punishments.

This study relies on a World Bank project. All data are derived from questionnaire surveys conducted by the project team in 2020 with residents of 10 districts (Haishu District, Jiangbei District, Beilun District, Zhenhai District, Yinzhou District, Fenghua District, Xiangshan County, Ninghai County, Yuyao City, and Cixi City), counties, and cities under Ningbo City (Figure 1). A total of 10,187 questionnaires were distributed, of which 9983 were valid, accounting for 97.98%. Interviews were also conducted with street and community staff, cleaning and property company sub-controllers, residents, and other relevant people. A detailed statistical description of variables is provided in Table 2.

Figure 1. Districts (*n* = 10) of questionnaire data in Ningbo City.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std.	Min	Max
REW	9983	0.958	0.2	0	1
PUN	9983	0.093	0.291	0	1
SEX	9983	0.541	0.498	0	1
AGE	9983	2.69	0.795	1	4
EDU	9983	2.5	1.037	1	4
JOB1	9983	0.055	0.227	0	1
JOB2	9983	0.306	0.461	0	1
JOB3	9983	0.246	0.43	0	1
JOB4	9983	0.129	0.335	0	1
JOB5	9983	0.23	0.421	0	1
IDN1	9983	0.095	0.294	0	1
IDN2	9983	0.263	0.44	0	1
IDN3	9983	0.038	0.19	0	1
HOM	9983	3.564	1.312	1	9
ELE	9983	0.641	0.48	0	1
TRAN	9983	0.594	0.491	0	1
FAC	9983	0.944	0.23	0	1
PROP	9983	0.929	0.257	0	1

Following ethical principles, although a large amount of primary data was collected, the questionnaire did not record any personal information (e.g., name, phone number, address) that could be traced back to the individual, and the questionnaire did not have the potential to cause privacy breaches or psychological harm to the data providers.

3.3. Modelling Adopted

This study intends to establish two models to analyze the influencing factors of residents' willingness to accept reward measures for DGC (model 1) and the influencing factors of residents' willingness to accept punishment measures for DGC (model 2) in China. Because of the explanatory variable Y_1, the residents' willingness to accept reward measures is a binary discrete variable, so model 1 is more appropriate to use the logit model. The model is set as follows:

$$Y_1 = \log\left(\frac{p_{ir}}{1 - p_{ir}}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i X_{ir} + \varepsilon_i \tag{1}$$

where p_{ir} represents the probability of residents' acceptance of DGC rewards, β_0 is the intercept term, X_{ir} is each explanatory variable (i.e., influencing factors of residents' willingness to accept DGC rewards), β_i is the coefficient of each explanatory variable, and ε is the error term.

Since the explanatory variable Y_2, the residents' willingness to accept DGC punishment measures is also a binary discrete variable, model 2 is also constructed by using the logit model. The model is set as follows:

$$Y_2 = \log\left(\frac{p_{ip}}{1 - p_{ip}}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i X_{ip} + \varepsilon_i \tag{2}$$

where p_{ip} represents the probability of residents' acceptance of DGC punishments; β_0 is the intercept term, X_{ip} is each explanatory variable, that is, the influencing factors of residents' willingness to accept DGC punishments; β_i is the coefficient of each explanatory variable, and ε is the error term.

4. Results and Discussion

In this study, the software Stata16 was used for the regression calculation of the datasets and to estimate the key parameters and their errors. To avoid multicollinearity,

16 explanatory variables were performed for the multicollinearity test (Table 3). Variance inflation factors (VIF) were applied in solving multicollinearity in a regression analysis. Generally, VIF of an explanatory variable reveals the strength of the linear relationship between the variable and the remaining explanatory variables.

Table 3. Test for multi-collinearity.

Variable	VIF
JOB2	7.016
JOB5	6.944
JOB3	6.275
JOB4	4.335
JOB1	2.573
AGE	2.037
IDN2	1.471
EDU	1.408
ELE	1.318
IDN1	1.274
HOM	1.215
SEX	1.178
TRAN	1.131
PROP	1.126
IDN3	1.124
FAC	1.069
AVERAGE VIF	2.593

A universal rule is that the VIFs greater than 10 (VIF > 10) give some cause for concern. Table 3 reveals that the VIF for all explanatory variables is less than 10, thus there is no obvious multicollinearity among the explanatory variables.

4.1. Reward Model Result

Using the logit model, the regression results of the factors affecting residents' willingness to accept domestic garbage classification rewards were obtained, as shown in Table 4.

Table 4. Logit regression result.

Variable	Coef.	St.Err.	*t*-Value
SEX	0.523 ***	0.12	4.34
AGE	0.384 ***	0.09	4.29
EDU	0.154 ***	0.059	2.62
JOB1	−0.08	0.335	−0.24
JOB2	−0.079	0.298	−0.27
JOB3	−0.449	0.293	−1.53
JOB4	−0.418	0.315	−1.33
JOB5	0.364	0.38	0.96
IDN1	−0.633 ***	0.177	−3.57
IDN2	−0.649 ***	0.139	−4.68
IDN3	−0.924 ***	0.218	−4.24
HOM	−0.12 ***	0.039	−3.07
ELE	0.346 ***	0.131	2.64
TRAN	0.279 **	0.111	2.52
FAC	1.084 ***	0.147	7.39
PROP	1.202 ***	0.139	8.62
Constant	0.243	0.406	0.6
Number of obs		9983	
Pseudo-R2		0.145	
Chi-square		Chi2 = 501.908	
Prob > Chi2		0.0000	

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

Table 4 reveals that there are 11 significant variables in the explanatory variables. The Pseudo-R2 of the model is 0.145, and the model's goodness of fit is good. The LR (likelihood ratio) statistical value of the likelihood ratio test (Chi-square) was 501.908, and the p value (Prob > Chi2) was 0.0000. When the LR value is larger and the p value is smaller, the stronger the ability to reject the original hypothesis H_0, that is, the explanatory power of the model is strong. The significance and influence degree of the factors affecting residents' willingness to accept DGC rewards are discussed as follows:

SEX, AGE, and EDU are positively correlated with REW ($p < 0.01$), indicating that women, older residents, and higher-educated residents are more willing to accept rewards for DGC (Table 4). This is consistent with existing research. Namely, women dispose of more housework including garbage classification and cleaning [47], and older people have more time for garbage classification, and therefore they participate in reward incentives and positively motivate themselves. Highly educated people may be more willing to take principled actions motivated by environmental protection [48]. In this case, the authors believe they are willing to motivate all people to participate in garbage classification and environmental protection through material rewards and create a virtuous cycle.

IDN1, IDN2, and IDN3 are negatively correlated with REW ($p < 0.01$), indicating that the property managers, the street, community and quarter staff, and cleaning staff are not inclined to accept DGC rewards. The main reason is that all three types of personnel are in the middle ground between the residents and the garbage disposal terminals, where they need to assist the residents in identifying and classifying the garbage, helping to upload the garbage that has already been classified, and so on. All these steps create a huge workload for them without bringing in corresponding subsidies, as the rewards end up going to the residents who put out the garbage.

HOM is negatively correlated with REW ($p < 0.01$), indicating that residents with more family members are less inclined to accept DGC rewards. This result is against the existing point that social networks and social capital promote public participation in low-carbon behaviors [49]. The authors tried to give possible reasons for this, i.e., the more family members there are, the more domestic garbage is produced, the more work is involved in DGC, and the more difficult it is to obtain a reward, so the respondents subjectively gave up this possibility.

ELE, TRAN, TAC, and EST positively correlate with REW ($p < 0.01$), indicating that the better the hardware, the more willing the residents are to accept the DGC rewards. This is likely because if external facilities are better, there are likely more things that can be recycled and clearer guidelines, making it easier to follow the rules. Thus, residents' awareness and willingness to classify domestic garbage would increase and garbage classification would be more efficacious [45]. On this basis, residents' willingness to accept DGC rewards is higher, as they have a better chance of getting rewarded.

4.2. Punishment Model Result

Using the logit model, the regression results of the factors affecting residents' willingness to accept DGC punishments are obtained, as shown in Table 5.

Table 5 reveals that there are 11 significant variables in the explanatory variables. The Pseudo-R2 of the model is 0.054, and the model's goodness of fit is good. The LR statistical value of the likelihood ratio test (Chi-square) was 335.903, and the p value (Prob > Chi2) was 0.0000. When the LR value is larger and the p value is smaller, the ability to reject the original hypothesis H_0 is stronger, that is, the explanatory power of the model is strong. The significance and influence degree of the residents' identity attributes factors affecting residents' willingness to accept punishment measures of DGC are discussed as follows:

EDU is positively correlated with PUN ($p < 0.01$), indicating that higher-educated residents are more likely to be receptive to DGC punishments (Table 5). The authors believe that the more educated people are, the more inclined they are to use rules and laws to constrain their own behavior and that of others.

Table 5. Logit Regression result.

Variable	Coef.	St. Err.	*t*-Value
SEX	−0.055	0.075	−0.73
AGE	0.037	0.064	0.58
EDU	0.114 ***	0.04	2.85
JOB1	−0.482 *	0.271	−1.78
JOB2	0.223	0.183	1.22
JOB3	−0.165	0.191	−0.86
JOB4	0.317	0.199	1.59
JOB5	−0.267	0.203	−1.32
IDN1	−1.261 ***	0.192	−6.56
IDN2	−1.034 ***	0.114	−9.08
IDN3	−0.268	0.209	−1.28
HOM	−0.063 **	0.031	−2
ELE	−0.453 ***	0.078	−5.78
TRAN	0.182 **	0.079	2.3
FAC	−0.219	0.145	−1.52
PROP	0	0.139	0
Constant	−1.775 ***	0.327	−5.42
Number of obs		9983	
Pseudo-R2		0.054	
Chi-square		Chi2 = 335.903	
Prob > Chi2		0	

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

JOB1 negatively correlates with PUN ($p < 0.1$), indicating that DGC punishments are not welcomed among farmers. This result is the reciprocate of other empirical evidence from China, which proved that farmers in regions with government penalties are more inclined to join garbage classification than those without interventions [50,51]. For reasons of geographic variation and government propaganda, we believe that such results for the sample are due to several reasons: farmers lack confidence, rural communities are poorly sensitized and ill-equipped, or the penalties are difficult to accept. Farmers are also more sensitive to punishments than rewards because they are willing to utilize recyclables independently. For example, paper, plastics, and foams can be used as fuels or primers. Furthermore, farmers' houses are big enough to store more recyclable garbage, and they can sell at a higher price to fixed recycling practitioners after accumulating a certain amount.

IDN1 and IDN2 are negatively correlated with PUN ($p < 0.01$), indicating that property managers, along with street, community and quarter staff are not willing to accept DGC punishments (Table 5). Perhaps because they are the ones who implement the punishment for DGC, they need to trace the source of misclassification, delivery and even littering at non-drop-off points, identify the situation and impose penalties. This is a "thankless" and easily irritating task for them.

HOM is negatively correlated with PUN ($p < 0.05$), indicating that residents with more family members are less inclined to accept DGC punishments (Table 5). Authors believe the reason for this result is the same as their reluctance to accept rewards. The significance and influence degree of the environmental attributes factors affecting residents' willingness to accept punishment measures of DGC are summarized and discussed as follows.

ELE is positively correlated with PUN ($p < 0.01$), indicating that residents who live in buildings without elevators are more inclined to accept DGC punishments (Table 5). Evidence showed that the primary causes of residents' negative emotions are flawed infrastructure and illogical waste-sorting practices [52]. Referring to this evidence, the study attributes this result to the fact that a quarter not equipped with an elevator is less convenient for garbage disposal and more likely to be dirty and that residents want to correct the behavior of others and maintain a tidy living environment through punitive measures.

TRAN is positively correlated with PUN ($p < 0.05$), indicating that residents whose quarter's garbage drop-off points are uniformly emptied are more likely to support the

punishment of DGC (Table 5). There is no literature to support a necessary correlation between the two. The field research and interviews gave us some reasons, i.e., uniform removal and transportation represent perfect cooperation between the waste disposal company and the quarter. As a result, residents believe that their quarter is not susceptible to punishment while hoping that the punishment will regulate the behavior of residents in other quarters.

Based on the discussions described above, several recommendations are being made to promote the establishment of a more scientific system of rewards and punishments to aid China in better implementation of domestic garbage classification:

i.   Rewards are the mainstay and punishments are a supplement to promote better DGC among residents. After all, DGC rewards should be better accepted than punishments. Although punishments are much more expensive and difficult to implement than the actual results they bring, the traditional form of economic punishment can be replaced by social services to mitigate residence from residents [53].

ii. We recommend upgrading the existing rules and regulations of DGC reward and punishment. It is found that different levels of hardware facilities affect residents' willingness. It is recommended that hierarchical rewards and punishments be formulated to consider the wishes of the residents of the old and new quarters [54].

iii. Punishments should be legally compliant and independently enforced. Since the property managers and community staff do not have the power nor the will to implement DGC punishments, the execution of punishments should be handed over to the city management and other relevant departments that can enforce the law [55].

iv. Governments should set up special funds in the DGC program, earmarked for rewards. The authors recommend paying property and quarter staff and cleaning personnel a corresponding and reasonable amount of compensation for their additional labor input portion due to DGC work. Enhance their motivation to work, and strengthen the guidance and management of this category of personnel on residents' DGC.

v.   Improvement in the quality evaluation mechanism of DGC to accurately distribute rewards. The existing mechanism for evaluating the quality of DGC is that the quarter staff opens the bag of food waste, takes pictures and uploads them to realize the evaluation of the effect of garbage classification by the backstage machine. However, this process is more susceptible to human factors, with problems such as errors in key information of garbage bags and poor quality of uploaded pictures, making it difficult for the back office to evaluate the process of residents' DGC effectiveness accurately.

To address the above problems, it is recommended that Chinese City, when implementing the evaluation of DGC quality in the future, adopt artificial intelligence technology and blockchain bookkeeping technology to accurately identify the quality of DGC in the bags swept by residents one by one. Rewards shall be calculated based on the quality of DGC for each household and directly issued to the residents' accounts.

5. Conclusions and Limitations

The scientific implementation of the garbage classification reward and punishment system improves the quality of classification at source, and enhances residents' conscious awareness in addition to increasing the efforts to combat plastic pollution and enhances the level of classification and recycling of living garbage. Using primary data from east City, an empirical analysis was employed to examine residents' willingness to accept rewards and punishment for domestic garbage classification (DGC) in China. The findings of this study are summarized as follows:

i.   Women and older residents are more willing to accept rewards for DGC. Higher-educated residents are biased to receive both rewards and punishments of DGC.

ii. The property managers; the street, community, and quarter staff; and the cleaning staff are not inclined to accept DGC rewards: the former two are likewise not inclined to support punishment.

iii. Residents with more family members are less inclined to accept DGC rewards or punishments.

iv.   DGC punishments are not welcomed among farmers. Non-farmers are not sensitive to either rewards or punishments.

v.   The better the hardware is, the more willing the residents are to accept the DGC rewards.

vi.   Hardware/external environment makes a difference in residents' acceptance of punishment. Residents who live in buildings without elevators are more inclined to accept DGC punishments while residents whose quarter's garbage drop-off points are uniformly emptied are more likely to support the punishment of DGC.

The authors want to point out that this study is not exempt from limitations, but the outcomes obtained may hold key implications for further research. First, this study uses cross-sectional data, so it is not possible to analyze the dynamics of residents' willingness to accept rewards and punishments for garbage classification. With the improvement of the garbage classification system and the introduction and adjustment of rewards and punishments over time, it will become more valuable to understand the dynamic links between changes in willingness and existing factors. Therefore, future research could use panel data to examine the association between residents' willingness and different influencing factors. Second, this study adopts a 01-type explained variable to represent the residents' willingness to accept rewards and punishments. However, given that residents' willingness is not black and white, but rather negotiable, if a more refined evaluation (such as 1–10 scoring) is adopted, the influence of each factor on the accepting willingness can be further quantified.

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