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Would Education Help Rural Residents to Stop Littering Solid Wastes? An Evidence in China

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Abstract

With the significant growth of economy since 1978, environmental issues in rural area are increasingly aggravated. In this research, hierarchical liner model (HLM) was applied to estimate inflecting factors of rural residents littering solid wastes. There are 3 main results: 1) random coefficient model is an effective method to estimate rural residents' behaviors; 2) environmental public policies should be designed by considering of regional differences; 3) enhancing education level is an appropriated way to help rural residents stopping illegal littering behaviors.

Keywords

Rural Residents, Behavior, Solid Wastes, HLM

1. Introduction

With the significant growth of economy since 1978, Chinese life condition has been remarkably improved. However, environmental issues in rural area are increasingly aggravated. Industrial wastes, excessive using of fertilizers and pesticides are playing extraordinary roles in environmental pollution in rural area of China. Besides, littering of solid wastes is also making Chinese rural environment deteriorated. Generally, there are 4 elemental catalogs of rural solid wastes: 1) Crop residues, for instance straws, weeds, leaves, cirrus, etc.; 2) Livestock and poultry residues; 3) Agricultural films; 4) Manipulate and domestic wastes [1]. However, solid waste is playing a vital role to damage environment out of 4 elemental catalogs [2].

Littering of non-pretreated solid wastes in rural area would cause public health crisis besides atmospheric, oceanic and edaphic issues. For instance, environment of rural community would be defaced by solid wastes and could re-

duce rural living qualities. Nevertheless, it has no effective methods and solutions to deal with solid wastes pollution in rural area notwithstanding the environment has significantly been damaged. Consequently, environmental preservation is of significantly importance and urgency to rural China. Protection policies should be designed to enhance the living environments and secured the public health in rural area.

In this research, a hierarchical liner model (HLM) was applied to estimate inflecting factors of rural residents littering solid wastes, and trying to explain: 1) What are the key factors of rural residents on illegally littering solid wastes? 2) Does education help Chinese rural residents to stop illegally littering solid wastes? 3) Does rural resident have different behaviors on littering in different regions? Based on these questions, questionnaire had been designed and investigated rural residents' attitude and behavior for dealing with solid wastes.

2. Literature Review

2.1. Agricultural Household Models

In terms of rural resident behavior, there were enormous theories should be concerned. Bamum and Squire [3] [4] had developed agricultural household behavior model which considered both of household socioeconomics and market variables. Moreover, Allan Low [5] had discussed about immigration behavior in rural South Africa and concluded that cross-market effect does exist on rural immigration. Furthermore, Singh and Strauss [6] had applied production choice model to estimate decision behavior in producing progress of rural labor. In addition, Michael Lipton [7], Dixit and Stiglitz [8], Fishbein and Ajzen [9], Lopez [10], Aylor [11], Ajzen [12] and Gasson [13] had contributed to theories of rural residents' behavior models.

Speaking of empirical studies, there were vast of researches discussed about rural household behaviors: Gonzalesand L. AD. [14], Huylenbroeck and Damasco-tagarino [15] discussed production behavior of peasants in Philippines by using CAM model. Andrew Dorward and Maria Maucer [16] discussed production and market behaviors of farm worker in France. Elizabeth J. Austin [17] had proposed structural equation models to exam decision behavior of rural residents. Maurizio Mazzocco [18] and John G. Mcpeak and Cheryl R. Doss [19], Frederic Vermeulen [20] were also studied individual preferences of behavior.

However, based on the features of rural household data, only a few of studies considered rural residents' behavior as a nested data and analyzed by concerning of data characteristics despite. Therefore, it would be necessary to study rural individual behavior by considering of group differences.

2.2. Hierarchical Linear Model

Hierarchical Linear Model (also known as HLM or random coefficient model) is an effective method for evaluation of structured data. It could help to separating variables residuals to explainable multilevel of differences [21]. Raudenbush [22]

criticized that HLM is an appropriated method to launch unbiased estimation for nested data.

In recent years, the numbers of using HLM to study the rural residents' behaviors has been increased. Zhang Xuyin [23] employed random coefficient model to estimate littering behavior of Chinese rural residents. Feng Xiaolong [24] examined adaptive behaviors of natural disaster of rural residents. Niu Xiaodong [25] analyzed rural residents' credit rationing in west regions.

3. Data Collection

HLM has various methods to collect data, such as household interviews, mail questionnaires, telephone survey and E-mailed questionnaires. However, the internet infrastructure has serious deficiencies in Chinese rural areas. The internet questionnaires were inaccessible to the most of rural residents. Thus, in where employed household interviews to collect demographic, cognitive valuation, psychological data in this research.

Fortunately, the numerous household data had been collected through questionnaires and had been approached in summer 2013, from April to August. The survey covered 30 provinces of China, including Hebei, Shandong, Henan, Anhui etc. There were 157 questionnaires has been removed due to missing information, and 4638 completed questionnaires has been employed in this study and the descriptive statistics is available at **Table 1**.

As an expectable result, the gender is consisting of male by 51.35% and the gender ratio of the survey data is 1.055 (male: female). Age level: In general, over 60% of respondents were 30 - 49 years old; about 18% of the respondents for 18 - 19 years old; about 18% of the total population were 50 to 59 years old and over 60. Education level, 46% of respondents had basic education, 23% of respondents had secondary education and 30% of respondents had tertiary education. With respect to income, the households' average annual income was 14,000 - 1600$. Therefore, this survey can accurately reflect the real condition of rural residents. The survey revealed that 51% of the respondents admitted that they had experience to discharge solid wastes illegally.

4. Methodology and Assumption

In this research, the rural residents' behavior model should be employed in section 2, thus:

$$Y = \beta_0 + \sum \beta_i X + u$$

where Y is rural residents' behavior, X is variable to examine influence on rural residents' behavior.

Therefore, Hierarchical Linear Model (also known as HLM or random coefficient model) was applied to analyze probabilities of discharging solid wastes of rural residents. The Bernoulli model was applied as:

$$fx(x) = p^x (1-p)^{1-x} = \begin{cases} p, x = 1 \\ 1-p, x = 0 \end{cases}$$

Table 1. Descriptive statistics.

Variable		Frequency	%
Gender	Male	2462	0.5135
	Female	2333	0.4865
Age level	18 - 29	867	0.1808
	30 - 39	1298	0.2707
	40 - 49	1738	0.3625
	50 - 59	600	0.1251
	Over 60	292	0.0609
Years of study	9 and less	2219	0.4628
	10 ~ 12	1125	0.2346
	13 ~ 15	372	0.0776
	16 ~ 17	910	0.1898
	Over 18	169	0.0352
Sources of income	Farm	2155	0.4494
	Farm and sideline	562	0.1172
	Migration Working	1371	0.2859
	Self-employment	700	0.146
	Livestock and aquaculture	240	0.0501
	Public employee	464	0.0968
	Etc.	651	0.1358
Elder in family	Yes	3494	0.7287
	No	1301	0.2713
Child in family	Yes	3724	0.7766
	No	1071	0.2234
Household Income (Chinese Yuan)	4000 and less	518	0.108
	[4000 - 6000]	438	0.0913
	[6000 - 8000]	358	0.0747
	[8000 - 10,000]	422	0.088
	[10,000 - 12,000]	394	0.0822
	[12,000 - 14,000]	207	0.0432
	[14,000 - 16,000]	352	0.0734
	[16,000 - 20,000]	396	0.0826
	[20,000 - 25,000]	303	0.0632
	[25,000 - 30,000]	258	0.0538
	Over 30,000	1149	0.2396
Lax supervision	Yes		0.3411
	No		0.6589
Conformity behavior	Yes		0.6008
	No		0.3992
Littering untreated wastes	Yes		0.5135
	No		0.4865

where $n = 1$, $X \sim Bn, p$, X is subject to Bernoulli distribution, $fx(x)$ is the probability density function, P represents the possibilities of discharging solid wastes of rural residents.

Therefore, LEVEL1 MODEL:

$$\text{Prob}(DROP = 1|\beta) = \varphi$$

$$Log\left[\frac{\varphi}{1-\varphi}\right] = \eta$$

$$\eta = \beta_0 + \beta_1(Job) + \beta_2(GENDER) + \beta_3(AGELV) + \beta_4(EDU) + \beta_5(REGGOV) + \beta_6(INFLU) + r$$

LEVEL2 MODEL:

$$\beta_0 = \gamma_{00} + \gamma_{01}INCOME + \gamma_{02}(EDUINVEST) + u_0$$

$$\beta_1 = \gamma_1 \cdots\cdots \beta_6 = \gamma_6$$

MIXED MODEL:

$$\eta = \gamma_{00} + \gamma_{01}INCOME + \gamma_{02}(EDUINVEST) + \beta_0 + \beta_1(Job) + \beta_2(GENDER) + \beta_3(AGELV) + \beta_4(EDU) + \beta_5(REGGOV) + \beta_6(INFLU) + u_0 + r$$

where Prob (Drop = $1|\beta$) = φ is individual probability of littering solid wastes, η is concocting to the Bernoulli distribution and could link the liner function Prob (Drop = $1|\beta$) to the logistic or probit model. And to the level-1 variables: Job, Gender, Agelv, Edu, Reggov, Influ are individual characteristic variables, which represents information of interviewees: whether working in field, gender, age level, education level, whether considering government is under lax supervision and whether claiming of conformity in group. Furthermore, to the level-2 variables: INCOME and EDUINVEST are regional characteristic variables, which represent reginal rural income and reginal educational investment. Thus, the final estimation of slope for level-1 model is following as:

$$\beta = \gamma_{0i} + \sum \gamma W + u$$

where, β is slope of level-1 model, W is reginal variable. Consequently, random intercept model is applied.

5. Results and Analysis

5.1. Descriptive Analysis

Over half of rural residents declared that they were experienced of littering untreated solid wastes illegally. It is revealed that over 65% of respondents believe that the local government was under the lax supervision in terms of environment. In addition, 60% of respondents would agree that their littering behavior was caused by group conformity. Thus, it implied that discharging untreated solid wastes in rural China is a routine. The environmental protection was becoming an acceptable concept for rural residents, nonetheless, most

of they would choose to ignore in routine life due to imperfection of infrastructure and insufficiency of education or advertisement on environmental prevention. That is a truly dilemma for implementing the rural solid waste recycling project in Chinese rural area. In general, there are two reasons might be intercepting to explain this phenomenon: 1) China rural residents have not form concepts of environmental protection as a developing country. They are used to having the lifestyle as natural economics era with outmoded customs; 2) Basis of the externality theory, the environment could be considered as a sort of element which is involved with external benefits or costs. Consequently, rational individuals would prefer to optimize their utilities to achieve maximum conditions. Therefore, as a rational rural resident, they would ordinarily deposit solid wastes with methods which would meet their maximum utilities, for instance, exposing wastes in remote places without pre-treatment. Both of reasons would cause the phenomenal above. Therefore, to discover factors that impact on rural residents' preferences is the initialized path to understand why and how rural residents would behavior on depositing solid wastes.

5.2. Estimate the Fixed and Random Effect Models

The model used stepwise regression method to introduce variables into the mixed model by considering the features of hierarchical linear model. Hence, HLM had been employed in this study to estimate the influences of respondents who discharge solid wastes.

It is noteworthy that $\tau_{00} = 0.16180$ is Variance estimation of intercept residuals for level-2. Contrasting with null model $\tau_{00} = 0.13878$, the proportion reduction in variance is (0.16180 − 0.13878)/0.13878 = 0.165874045, Therefore, regional variables would explain 16.95% variance of null model, and reliability estimation is greater than 0.5 (0.674). In other words, employing regional variables could optimize original model.

1) Intercept β_0 estimates possibility of littering solid wastes for a rural not peasant female who is coming from an average income region and accepting average education is 1/ (1 + EXP (−0.4548)) = 0.61178, 61.18%.

2) Education variable: based on the results in Table 1, the education level is statistically significant in level-1 model. It means that possibility of littering untreated wastes would be reduced 16% by increasing of individual education level. However, based on the result of level-2, there is no remarkably evidence to support the point of view that regional education level would help rural residents to decrease the possibility of discharging solid wastes illegally.

3) Income variable: in term of regional household income level, rural residents who are coming from high income family would have less chance to discharge wastes, and the odds ratio is 0.999962. In another word, predicted probability for discharging wastes is:

$$\text{Predicted probability} = \frac{1}{1+\exp^{(-\text{predict})*\log it}}$$

Therefore, predicted probability of discharging wastes would be reduced by regional income level upgrading. Nevertheless, according to Chart 1, there is significant evidence of the 'law of diminishing marginal utility'. The marginal reduction of predicted probability will be decelerating while regional income level is boosting.

4) Socioeconomics variables: according to results on Table 2, the gender, age level and job are statistically significant. Subject to result, male would discharge wastes illegally more than female by 29%, and peasant would litter solid wastes illegally more than others by 18%. Moreover, elder rural residents have a greater possibility to discharge untreated solid wastes, the odds ratio is 1.138091, and thus predicted probability is 0.459938.

5) Psychological variables: subject to the regression's results in Table 2, two attitude variables would be significant interpretation. Respondents frequently considered the government would be under the lax supervision for rural pollution controlment may have higher probability to discharge solid wastes illegally by 36%. In addition, to rural residents, who believe their discharging behaviors were infected by their neighbors would have higher probabilities by 66%. This is another evidence to support that education is a key factor to reduce probability of illegally discharging wastes. Since psychological factors could be influenced by educating and advertising.

6. Conclusions

The initial objective of this research was to evaluate whether socioeconomic status is the key reason to influence rural residents' behavior of discharging untreated wastes. The important ingredients in this research were to understand

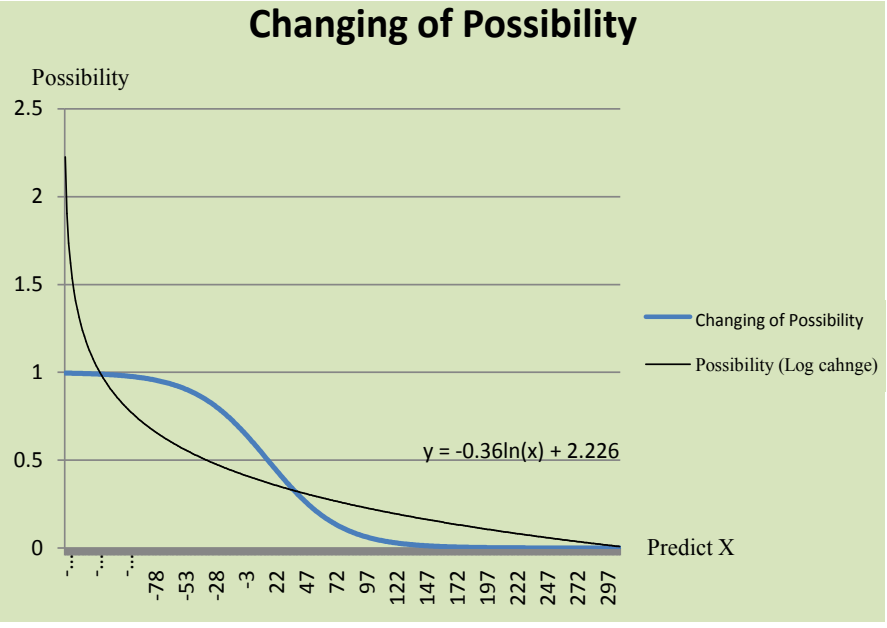

Chart 1. Changing of possibility.

Table 2. Mixed effect model.

	Fixed Effect	Coefficient	Standard Error	Odds Ratio*
	INTRCPT1 B0			
	INTRCPT2, G00	0.454800	0.307242	1.575858
	INCOME, G01	−0.000038	0.000031	0.999962
	EDUINVEST, G02	0.016477	0.037963	1.016613
	JOB slope, B1			
	INTRCPT2, G10	0.166323	0.064834	1.180954
	GENDER slope, B2			
	INTRCPT2, G20	0.254920	0.062558	1.290358
	AGELV slope, B3			
	INTRCPT2, G30	0.129352	0.032929	1.138091
	EDU slope, B4			
	INTRCPT2, G40	−0.164540	0.030127	0.848284
	REGGOV slope, B5			
	INTRCPT2, G50	−0.448074	0.067305	0.638857
	INFLU slope, B6			
	INTRCPT2, G60	0.508043	0.065567	1.662036
	Random level-1 coefficient		Reliability estimate	
Tau	INTRCPT1, B0	0.16180	0.674	

*: Odds Ratio also known as Cross-product Ratio.

whether education could help rural residents to stop littering untreated wastes. It will be useful to politician when making rural environmental public policies. Out of 4638 households, 51% were admitting that they had experience to discharge solid wastes illegally.

In conclusion, there are 3 main results: 1) HLM was successfully employed in this research. It means that in speaking of littering behaviors for Chinese rural residents, random coefficient model is an effective method to avoid biased estimation. 2) Rural residents' littering behavior is different in distinct regions. Hence, environmental public policies should be designed by considering of regional differences. 3) Education is revealed outstanding importance to decrease probabilities of littering behaviors. Most of statistically significant variables in research are relating to education more or less. Thus, enhancing education level is an appropriated way to help rural residents stopping illegal littering behaviors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Yang, Y. and Chen, J.S. (2003) Analysis and Prevention of Farmland Pollution. *Journal of Hefei University of Technology* (*Social Sciences*), **17**, 146-148.

[2] Zhang, X.Y. (2015) The Emission of Solid Wastes in Rural Area and Its Prevention and Control Strategy.

[3] Barmum, H.N. and Suqire, L. (1979) An Econometric Application of the Theory of Farm-Household. *Journal of Development Economics*, **6**, 79-102. https://doi.org/10.1016/0304-3878(79)90037-3

[4] Barmum, H.N. and Suqire, L. (1979) A Model of an Agricultural Household: Theory and Evidence. World Bank Staff Occasional Papers. International Bank for Reconstruction and Development, No. 27.

[5] Low, A. (1986) Agricultural Development in Southern Africa: Farm Household Economics and the Food Crisis. James Currey, London, 118-152.

[6] Singh, I. and Strauss, S. (1986) Agricultural Household Models: Extensions, Applications and Policy Baltimore MD. Johns Hopkins University Press, Baltimore, Maryland.

[7] Lipton, M. (1968) The Theory of the Optimizing Peasant. *Journal of Development Studies*, No. 4, 3.

[8] Stigiitz, D. (1977) Monopolistic Competition and Optimum Product Diversity. *American Economic Review*, **67**, 297-308.

[9] Ajzen, I. and Fishbein, M. (1980) Understanding Attitudes and Predicting Social Behavior. Prentice-Hall, Inc., Englewood Cliffs, NJ.

[10] Ramon, L. (1986) Structural Model of the Farm Household That Allow for Interdependent Utility and Profit-Maximization Decisions. Agricultural Household Models-Extensions, Applications and Policy. The Johns Hopkins University Press, Baltimore.

[11] Aylor, D.E. (1987). Deposition Gradients of Uredinospores of *Puccinia recodita* near a Source. *Phytopathology*, **77**, 1442-1448. https://doi.org/10.1094/Phyto-77-1442

[12] Ajzen, I. (1991) The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, **50**, 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

[13] Ruth, G. (1993) The Family Business. CAB INTERNATIONAL.

[14] Gonzales. L.A. (1993) Economic Incentives and Comparative Advantage in Indonesian Food Coproduction. The International Food Policy Research Institute.

[15] Huylenbroeck, G. and Damasco-Tagarino, D. (1998) Analyzing Crop Choice of Philippine Vegetable Farmers with Multicriteria Analysis. *Journal of Multi-Criteria Decision Analysis*, **7**, 160-168. https://doi.org/10.1002/(SICI)1099-1360(199805)7:3<160::AID-MCDA186>3.0.CO;2-L

[16] Dorward, A. (2006) Market and Pro-Poor Agricultural Growth: Insights from Livelihood and Informal Rural Economy Models in Malawi. *Agricultural Economics*, **35**, 157-169. https://doi.org/10.1111/j.1574-0862.2006.00149.x

[17] Austin, E.J., Deary, I.J. and Willock, J. (2001) Personality and Intelligence as Predators of Economic Behavior in Scottish Farmers' Progress. *European Journal of Personality*, **15**, 123-137. https://doi.org/10.1002/per.421

[18] Mazzocco, M. (2007) Household Inter Temporal Behavior. A Collective Characterization and a Test of Commitment. *The Review of Economic Studies*, **74**, 857-895.

[19] Mcpeak, J.G. and Doss, C.R. (2006) Are Household Production Decisions Cooperative Evidence on Pastoral Migration and Milk Sales from Northern Kenya. *American Journal of Agricultural Economics*, **88**, 525-541. https://doi.org/10.1111/j.1467-8276.2006.00877.x

[20] Vermeulen, F. (2007) Collective Household Models Principles and Main Results. *Journal of Economic Surveys*, **16**, 533-564. https://doi.org/10.1111/1467-6419.00177

[21] He, X.Q. and Ming, S.Q. (2009) Centralized Study of HLM for Level-1 Variables. *Statistics & Information Forum*, **249**, 49-52.

[22] Raudenbush, S.W., Bryk, A.S. and Guo, Z.G. (2007) HLM: Applications and Data Analysis Methods. Social Sciences Academic Press, Beijing.

[23] Wang, R.M., Zhang, X.Y., Zhang, X.L. and Wu, T.Z. (2015) Impact Factors on Rural Solid Wastes Behavior—An Empirical Study from Shandong Province. *Journal of China Agricultural University* (*Social Science Edition*), **32**, 90-98.

[24] Feng, X.L., Chen, Z.X. and Huo, X.X. (2015) Influencing Factors of Apple Farmer Adaptation to Meteorological Disasters. *Resources Science*, **37**, 2491-2500.

[25] Niu, X.D. (2017) Study on the Effect of New Rural Financial Institution on Supporting Agriculture in West China-Based on the View of Farmer's Credit Availability, Satisfaction and Welfare.