sustainability

MDPI

Article

Exploring Heterogeneous Preference for Farmland Non-market Values in Wuhan, Central China

Xin Yang [1], Michael Burton [2], Yinying Cai [1] and Anlu Zhang [1,*]

Received: 29 October 2015; Accepted: 17 December 2015; Published: 23 December 2015
Academic Editor: Marc A. Rosen

[1] College of Land Management, Huazhong Agricultural University, Wuhan 430070, China; yangxin@mail.hzau.edu.cn (X.Y.); caiyinying@mail.hzau.edu.cn (Y.C.)

[2] School of Agricultural Resource and Economics, The University of Western Australia, Crawley 6009 WA, Australia; michael.burton@uwa.edu.au (M.B.)

* Correspondence: zhanganlu@mail.hzau.edu.cn; Tel.: +86-27-8728-6895; Fax: +86-27-8728-6798

Abstract: The research question for this study is estimating the public's willingness to pay for the public goods generated by farmland, and exploring respondents' heterogeneity in their preferences for these goods. The approach used is a choice experiment, using respondents from the city of Wuhan, China. Six attributes representing public good values (farmland area, farmland fertility, water quality, air quality, species richness, and recreational value) and the level of private cost are selected in this study. A heteroscedastic conditional logit model is used to analyze the respondents' willingness to pay for improvements in these public goods, accounting for systematic heterogeneity in public preferences. The results show the public are willing to pay to preserve the non-market values generated by farmland, with air quality valued most and followed by farmland fertility, farmland area, water quality, species richness and recreational value. In addition, respondents with higher income, and who are aware of the non-market values of farmland and have a willingness to pay for it have a smaller error variance, *i.e.*, these respondents are more consistent in their choices. This study may help decision makers improving more differentiated farmland protection policies.

Keywords: choice modeling; citizens; error variance; farmland non-market values; willingness to pay

---

1. Introduction

In China, as in other countries, the management of farmland may generate public goods, *i.e.*, water quality, air quality and species richness and recreational activity. People may also have concerns about the area of farmland, and the fertility of farmland in terms of food security and quality, although whether farmland fertility has a direct impact on quality of agricultural products or not is still debated [1,2]. In this paper, we want to explore how citizens value these public goods, the extent to which there is heterogeneity in respondents' preferences for non-market values of farmland, and whether that heterogeneity can be explained by observable characteristics. It is common that preferences for certain goods or services vary across respondents, and the consideration of heterogeneity in individuals' preferences for goods and services is taken as one of the most significant areas of research within choice experiments, as it can generate an unbiased result compared to a constrained version that assumes homogeneity throughout the population [3–5].

There are a number of methods by which heterogeneity in preferences can be considered. Here we explore observable heterogeneity based on socio-demographic variables reported in the survey, and heterogeneity in the error variance using a heteroscedastic conditional logit model. It reflects a behavioral interest in factors influencing the variance of the latent variables in the model [6,7], and shows the heterogeneity in respondents' preferences for certain goods [8].

The paper is organized as follows. Section 2 describes the literature review on farmland non-market value. Section 3 introduces the study area, choice model design, and data collection. Results of a heteroscedastic conditional logit model are presented in Section 4. Section 5 illustrates how the results can be used to estimate the partworths of each attribute, and comparisons are made within or across the attributes. Section 6 reports the policy implications for farmland management and the conclusion of this study.

2. Literature Review on Farmland Non-Market Values

Farmland is a valuable non-renewable natural resource that serves important economic and environmental functions [9–11]. The values of these functions are difficult to quantify in monetary terms and often enjoyed by people in the form of quasi-public goods. Thus, estimating the public's willingness to pay for the public goods generated by farmland and exploring respondents' heterogeneity in their preferences for these non-market values have been an area of increased research by economists and policymakers. The two main stated preference techniques that are suitable for non-market value estimation are contingent valuation and choice modeling.

The contingent valuation method (CVM) was the most widely used model for estimating non-market values before the establishment of choice modeling. Bishop and Heberle [12] proposed that one could construct a hypothetical market and observe individuals' maximum willingness to pay for an option, or instead stay with the current level of non-market goods or services. It soon become popular in many fields for its simplicity and clarity in producing a single estimate of the values of non-market goods or services, such as rural landscape, recreational activities, wildlife habitat and water improvement [9,13–19].

However, specific attributes of farmlands non-market value cannot be quantified by CVM, which makes policymakers cautious about using this method [20,21]. This problem has been resolved by the development of choice modeling (CM). It is a stated preference technique that has some similarities to the CVM but has some notable improvements. Respondents are asked to make a series of choices between several different goods that are defined using a common set of attributes, and the value of specific attributes becomes possible. Originating in transportation research in 1983 [22], choice modeling has frequently been used to estimate non-use values in various fields during the past 20 years [23–28]. It has also been used to estimate non-market values of agricultural land or farmland [23,29–32].

However, limitations still exist: the heterogeneity in respondents' preference for farmland non-market values is often neglected. In most applications of the conditional/multinomial logit model, the error term is assumed to be homoscedastic [33]. To our knowledge, the existing Chinese studies that have explored the heterogeneity in respondents preference for farmland non-market values are still not sufficient. The aim of this paper is to assess citizens' willingness to pay for various attributes of farmland non-market values (farmland area, farmland fertility, water quality, air quality, species richness, recreational value) by employing the choice modeling framework. Respondents' socio-demographic characteristics, as well as attitudes are used to account for the heterogeneity across their preferences through a heteroscedastic conditional logit model.

3. Methodology

The heteroscedastic conditional logit model has its roots in Random Utility Theory [34], which assumes respondents utility depends on their choices from some available sets made up with attributes, and they are willing to buy or pay for these attributes [35]. However, some of this unobservable consumer utility can be explained, while some random element remains unexplained as the modeler does not possess complete information concerning the individual decision maker [36]. Thus, utility (U_{ijn}) of individual preferences can be written as the sum of a systematic (V_{ijn}) and random (ε_{ijn}) components:

$$U_{ijn} = V_{ijn}(Z_{ijn}, \theta) + \varepsilon_{ijn} \quad (1)$$

where U_{ijn} is the total utility which individual i will get by choosing option j in choice set n, V_{ijn} represents the observable systematic component of utility that is the explainable proportion of the variance in utility of option j, Z_{ijn} are the attributes associated with option j, θ is a vector of coefficients reflecting the desirability of the attributes, and ε_{ijn} is the random term independent of V_{ijn}.

Option j rather than k ($j \neq k$) in choice set C will be chosen if the utility of j is greater than that generated by all other options of choice set n, *i.e.*, option k, then the probability for all j options in choice set n can be expressed as:

$$P_{ijn}\left(j/C_n\right) = P\left(U_{ijn} > U_{ikn}\right) = P\left(V_{ijn} + \varepsilon_{ijn} > V_{ikn} + \varepsilon_{ikn}\right), j \neq k \tag{2}$$

Maximum likelihood functions are as follows:

$$\text{In}\, L = \sum_i \sum_j \sum_n d_{ijn} \text{In}(P_{ijn}) \tag{3}$$

where, d_{ijn} is a dummy variable (if choose j, then d_{ijn} is 1, otherwise 0). Assuming the random error terms are distributed independently and identically with each other (IIA), and belong to the Gumbel distribution (0 or 1), then the selection probability P_{ijn} can be expressed by Conditional Logit Model (CLM):

$$P_{ijn} = \frac{\exp\left(\lambda V_{ijn}\right)}{\sum_n \exp\left(\lambda V_{ijn}\right)} \tag{4}$$

where λ is a scale parameter that is inversely related to the error variance, which is usually normalized to equal 1 as it cannot be identified independently from the error variance of the data σ^2, it can be written as:

$$\lambda = \frac{\pi}{\sqrt{6\sigma^2}} \tag{5}$$

However, this assumption of a constant error variance across individuals has been questioned and alternatively a heteroscedastic conditional logit (HCL) model [37] has been proposed. In this paper, the scale parameter λ is no longer a constant term as it allows for unequal variance across survey characteristics, such as individual characteristics. This is different from the latent class model, which automatically classify the heterogeneous respondents into a series of segment (m) , each segment has its own scale parameter λ_i and all the scale parameter ($\lambda_i = i = 1, 2, \ldots, m$) sums up to 1 [8]. The heteroscedastic logit model is a more suitable model to explore the heterogeneity that exists in people preference when respondents' preferences are heterogeneous but can not be expressed by limited number of segments.

$$P_{jn} = \frac{\exp\left(\lambda V_{jn}\theta\right)}{\sum_n \exp\left(\lambda V_{jn}\theta\right)} \tag{6}$$

where λ is a function of respondents' socio-demographic characteristics, the parameterization of λ can be done as exp ($S_m\gamma$) with (S_m) a vector of the individual socio-demographic characteristics and γ as a vector of parameters indicating the influence of those characteristics on the error variance. If γ turns out to be zero, then the heteroscedastic logit collapses to a conditional logit. For estimating the heteroscedastic conditional logit model we use the STATA 12 *clogithet* command written by Hole [33].

As for the application in this study, the attribute variables of farmland area, farmland fertility, water quality, air quality, species richness, recreation value and cost can be described in the form of linear functions of attribute vector (Z_i). The respondent's socioeconomic status can be also used to interact with the Status Quo and the attributes. Formally, if we have the attribute vector Z_i as above, we use a linear utility model to explain individual choice. The linear utility index for alternative j in choice task n for respondent i can be expressed as.

$$V_{ijn} = SQ + \sum_t \beta_{it} Z_{tjn} \tag{7}$$

where *SQ* is alternative specific constant (ASC) for status quo; β_{it} are the parameters associated with the t attributes, which can be conditioned on observable characteristics of the individual to allow for heterogeneity in preferences.

Based on the conditions of maximization of individual utility, each attribute value of farmland (namely, WTP) can be expressed as:

$$WTP_{it} = -\frac{\beta_{it}}{\beta_{im}} \tag{8}$$

where β_{im} is the marginal utility of income of individual *i*.

4. Case Study, Survey Design and Implementation

4.1. Case Study Description

Wuhan is the largest city in central China, it located at the intersection of the middle reaches of the *Yangtze* River and its largest tributary *Han* River. Having a population of eight million, Wuhan has direct jurisdiction over seven central districts and six rural districts (Figure 1). The whole area of the city is nearly 850,000 hectares, 575,000 hectares of them are farmland. Owing to the acceleration of the industrialization and urbanization process [38], more than 5000 hectares of farmland are converted into urban land every year. Moreover, the excessive use of pesticides and chemical fertilizers has exerted a great threat on the farmland environment. The decline in quantity and degradation in quality of farmland have brought serious challenges for farmland management [39,40]. Many of the values associated with these changes are difficult to quantify in monetary terms and often consumed by people in terms of quasi-public goods. In fact, protecting farmland has been one of the most important land administration issues not only for the local policy makers but also for the Chinese central government [41].

Residents' opinions and participation are crucial for the designing of a successful farmland protecting policy. Thus, the challenge for policy makers is to find a consumer-oriented farmland improvement program, which can reflect local residents' willingness to pay and also truly express the heterogeneity of their preferences [30]. Within this context, quantifying the public's willingness to pay for the public goods generated by farmland, and exploring respondents' heterogeneity in their preferences for these values, is urgently needed by policy makers.

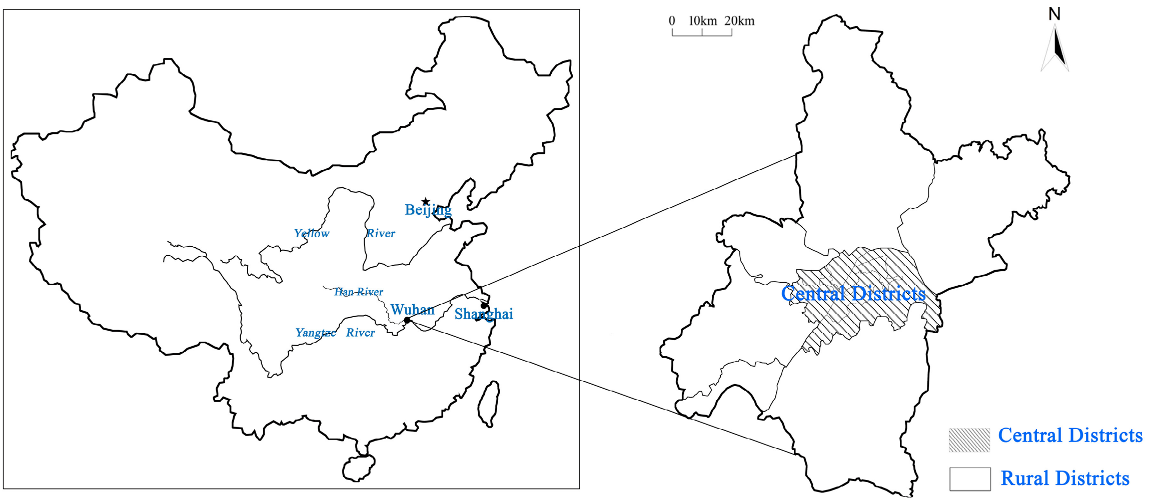

Figure 1. Location of the research area.

4.2. Survey Design and Implementation

Appropriate attributes can specify the outcomes presented to the respondents as well as get the information we need. After seeking advice of experts from the field of agriculture and land resource management, six attributes (farmland area, farmland fertility, water quality, air quality, species richness, recreational value) and cost are selected to represent public good values of farmland [42]. Each respondent is presented with a choice set made up with those six attributes and a private cost in this study.

Levels of cost attribute in this paper are determined by referring to a CE survey in Wuhan [23]. The description, code name and their levels of each attribute are presented in Table 1, the status quo option levels are those underlined.

Table 1. The attributes and their levels.

Attributes	Description	Levels	Code Name
Farmland area (10,000 hectare)	Amount of farmland	**575**, 576, 577, 578	Farma
Farmland fertility	The soil fertility and natural capability of farmland	**Fourth-Class**, Third-Class, Second-Class, First-Class	Farmf_4, 3,2,1,
Water quality	Proportion of qualified water from the main river's section	**70%**, 75%, 80%, 85%	Waterq
Air quality	An index used to show how polluted the air is	**Fourth-Class**, Third-Class, Second-Class, First-Class	Airq_4,3,2,1
Species richness	The number of different species represented in farmland ecological community	**2500**, 2505, 2510, 2515	Species
Recreational value (1000 Yuan)	The value of farmland's ability to provide people with enjoyment, amusement, or pleasure	**¥5**, ¥5.5, ¥6, ¥6.5	Recv
Payment to farmland non-market values(Yuan)	How much is your family willing to pay to preserve the above values generated by farmland annually?	**0**, 50, 100, 150, 200	Cost

The options making up the choice sets are formed by allowing attribute levels to vary systematically according to an experimental design. The above attributes and their levels can generate $4^6 \times 5 = 20{,}480$ possible options, which is impossible to implement. Choosing the optional number of choice sets for the survey is dependent on two particular aspects: reducing cognitive burden for the respondents; and finding a number suitable to create efficient experimental designs. In this paper, an orthogonal fractional factorial design is used to minimize the numbers of choice sets that are required while still allowing identification of preferences [43]. Moreover, three options with the inclusion of the status-quo option is a suitable way to obtain welfare measures that are consistent with demand theory and to avoid biases in the WTP estimates [22]. After putting all this information into the *Ngege*, we can get the minimum number of choice sets needed to get a robust result, which is 14 in this manuscript. Particularly, 10 is the minimum number of choice sets for each respondent—a questionnaire with more than that will bring too heavy a cognition burden to them [43]. Thus, the 14 choice sets were blocked by a factor of 2. Each respondent was presented with seven choice sets in each block, containing three scenarios for him/her to select from: option A or B (representing new polices) and the status quo. Table 2 is an example of a choice set used in this study.

In this study, there are three parts of the questionnaire, (1) respondents' cognition of the present situation of farmland on market values in Wuhan, China. (2) One of two blocks of seven choice sets, assigned at random. (3) Respondents' socio-demographic characteristics (age, education level, gender, income, and householder or not) and their attitude towards farmland non-market values (being aware of it or not, whether they are willing to pay to protect it or not). Data from part (3) can be required as inputs into the modeling as well as for checking on how well the sample represents the population.

Table 2. An example of choice set.

Attributes	Status Quo (SQ)	Option A	Option B
Farmland area (10^4 t)	575	578	577
Farmland fertility	**Fourth-Class**	Second-Class	Second-Class
Water quality	70%	70%	75%
Air quality	**Fourth-Class**	Fourth-Class	First-Class
Species richness	2500	2510	2510
Recreational value	¥5000	¥6000	¥5000
Pay for the farmland non-market values: Yuan	0	150	100
Please choose your most preferred option by placing a tick in the ( )	( )	( )	( )

The survey are conducted in the central districts of Wuhan, China. Citizens were surveyed by 13 trained enumerators between December 2013 and January 2014. A pilot survey was done before the final versions of the questionnaire were conducted face-to-face. Three hundred respondents were investigated by referring to the sample size formula of Scheaffer *et al.* [44], which includes 150 surveys of each version. The numbers of useable questionnaires for Block 1 is 147 (98.00%) and for Block 2 is 141 (94.00%). In total, we have 2016 (288 × 7) choice observations.

5. Results

5.1. The Results of the Cognition Questions

Respondents' cognition of farmland non-market values is the basis for their willingness to pay for it. Each respondent is presented with the following questions: "Do you hold the opinion that the farmland area (farmland fertility/water quality/air quality/species richness/ recreational value) is important in your life" and "Have you realized that the farmland area (farmland fertility/water quality/air quality/species richness/recreational value) is decreasing fast?" and asked to answer on a 5-point Likert-scale their degree of agreement. Table 3 below reports the mean scores for the six attributes, for both *Importance* and awareness of *Decline*.

Table 3. Responses of the attributes.

Attribute	Importance	Decline
Water quality	4.1664	4.0902
Air quality	4.1158	4.1246
Species richness	3.8586	3.7649
Farm fertility	3.7048	3.7031
Farm area	3.6962	3.7644
Recreational value	3.3288	3.2194

Table 3 shows that respondents hold the opinions that water quality is the most important one among the six attributes, followed by the attribute of air quality, with their mean scores both over 4 points. Individuals are also most aware that air quality is decreasing, followed by water quality. These are partly because of the serious hazy weather and the frequent water pollution incidents in Wuhan during the past five years.

5.2. Definition of Socio-Demographic Variables

Respondents are also presented with attitude questions like "Are you aware of the farmland non-market values in Wuhan", "Do you have a willingness to pay for farmlands non-market values".

Respondents' socio-demographic characteristics are also reported in Table 4, which includes their age, income, whether a householder or not, and whether the family has savings or not.

Table 4. Descriptive statistics of survey sample.

Attributes	Definition	Mean
Gender	Male = 0, Female = 1	0.3086
Age	Respondents' age	32.6703
Education level	Years of education received by the respondent	13.8433
Income (1000 Yuan)	Income of the respondents	3.0608
Holder	Household, yes = 1, no = 0	0.3667
Aware	Are you aware of farmland non-market values? yes = 1, no = 0	0.7969
Willingness	Do you have willingness to pay to protect farmland non-market values? yes = 1, no = 0	0.7734
Savings	Does your family have savings? yes = 1, no = 0	0.8008

Table 4 indicates that 79.69% respondents are aware of the farmland non-market values in Wuhan and 80.08% of their families have savings. Moreover, 77.34% of the public have willingness to protect farmland non-market values.

5.3. Results of the Heteroscedastic Conditional Logit Model

Some attributes (farm fertility and air quality) are categorical variables, and enter into the model as dummy variables with level 4 (the worst quality for both attributes) as the baseline. Interactions between attributes and socio-demographic characteristics are also included in the model: only those that have been identified as being particularly robust are reported in Table 5. It is notable that the only effect identified relate to the marginal utility of the cost attribute.

This heteroscedastic conditional logit model [16,33,37] assumes that there may be heterogeneity in the error variance across participants. In the estimated model, the scale parameter is modeled as a function of individual socio-demographic characteristics (S), *i.e.*, $\lambda = \exp(\delta\ S)$. Those that are significant are reported. Heterogeneity in preferences was also explored using a latent class model, but the results were no more informative than those reported here in Table 5.

Table 5. Results of the heteroscedastic conditional logit model.

Attributes	Coef.	z	$P > \lvert z \rvert$	[95% Conf. Interval]
ASC	−0.3505	−3.03	0.0020	−0.5771, −0.1239
Farma	0.0511	2.83	0.0050	0.0157, 0.0865
Farmf_1	0.1328	2.26	0.0240	0.0176, 0.2480
Farmf_2	0.0859	2.26	0.0240	0.0115, 0.1602
Farmf_3	0.1296	2.45	0.0140	0.0259, 0.2333
Waterq	0.0263	3.82	0.0000	0.0128, 0.0398
Airq_1	0.2312	3.49	0.0000	0.1012, 0.3612
Airq_2	0.1897	3.04	0.0020	0.0673, 0.3120
Airq_3	0.1492	2.89	0.0040	0.0480, 0.2504
Species	0.0061	1.80	0.0720	−0.0005, 0.0127
Recv	0.0001	1.96	0.0500	0.0000, 0.0001
Cost	−0.0013	−1.43	0.1530	−0.0030, 0.0005
Cost*Willingness	0.0019	2.05	0.0400	0.0001, 0.0037
Cost*Savings	−0.0012	−2.43	0.0150	−0.0021, −0.0002
Scale Equation				
Willingness	0.9879	5.78	0.0000	0.6527, 1.3232
Aware	0.3216	2.52	0.0120	0.0717, 0.5715
Income	0.0000	−1.69	0.0920	0.0000, 0.0000

Heteroscedastic logistic regression; Number of obs = 5484; Number of groups = 1828; LR $chi^2(18) = 74.50$; Prob. > $chi^2 = 0.0000$; Log likelihood = −1483.6326.

All the estimated coefficients of the seven attributes have the expected signs. The coefficient for the ASC is negative and significant at the 1% level, which indicates that respondents value a shift away from the Status quo condition more than one might anticipate based on the status quo attribute levels alone.

The coefficient for the variable of farmland area is positive and significant at 1% level.

Farmland fertility is defined as a categorical variable in this paper so it goes in as a set of dummies, with level 4 (the worst level) as the base. Coefficients for all the levels of farmland fertility are positive and significant at 5% level, but seem to suggest a lack of sensitivity to the level of farm fertility. For water quality, the sign of its coefficient is positive and significant at 1% level, indicating there is a clear progression of the utility of respondents as the water quality increase.

The response to air quality showed a similar effect as farmland fertility: coefficients for all the levels of air quality are positive and significant. Moreover, the results also indicate that higher level of air quality is more preferred by respondents, so are their significant levels, with 0.2312, 0.1897, and 0.1492 for the level of Air_1, Air_2, and Air_3, respectively. Respondents in Wuhan favor improved air quality. The effect of species richness on respondents' utility is positive and significant at 10% level, and for recreational value (significant at 5% level).

The coefficient of cost is negative, which indicates that the utility of respondents will decrease when there is a rise in cost. However, there are number of significant interaction effects identified. Specifically, the attitude variable *willingness*, reduces (the absolute) value of the marginal utility of cost. Respondents who report a willingness to pay for protection (*willingness* = 1) will have a higher WTP estimate. On the other hand, those who have a bank deposit (*savings* = 1) will tend to have a lower willingness to pay, as those respondents would prefer saving rather than spending.

Given the importance of the marginal utility of cost in determining WTP, it is informative to identify its value for the four identifiable subsections of the sample, and their prominence, as well as the sample mean. Table 6 reports this.

Table 6. Implied marginal utility of money, by type of respondent.

Group	% in Sample	MU of Cost	$P > \lvert z \rvert$
willingness = 0, *savings* = 0	4.64	−0.0013	0.153
willingness = 1, *savings* = 0	14.99	0.0006	0.169
willingness = 0, *savings* = 1	17.39	−0.0024	0.014
willingness = 1, *savings* = 1	62.98	−0.0006	0.027
willingness = 0.77, *savings* = 0.80	100.00	−0.0008	0.017

Table 6 reveals that for the majority of the sample, the coefficient associated with cost is negative and significant: for only 19.63% is the cost coefficient not significantly different from 0. The implications of this are considered in the following section.

5.4. Partworths and Its Aggregation

One of the roles of choice modeling is to examine the partworths of changes in farmland management. Based on Equation (8), the calculation of partworth allows monetary values to be ascribed to the attribute levels. According to the results of estimated the parameters, assuming the other attribute being equal, we can evaluate the marginal value of an attribute compared to its baseline level. The marginal value is the public's willingness to pay (WTP), which means how much the respondents are willing to pay for a marginal change in attributes. Partworths reported in Table 7 are calculated when the socio-demographic variables are at their mean values (*willingness* = 0.7734, *savings* = 0.8008, and the respondents' marginal utility = −0.0008). It should be noted that these values are all estimated by compared with the attributes' baselines, which can be checked in Table 1.

Table 7 reports the mean partworths for each attribute level. There are some noteworthy features in this study deserve to be reported before list the partworths. It should be noted that these values in the first column are all estimated by comparison with the attributes' baselines, which can be checked in Table 1.

Table 7. Mean partworths for a marginal and 1% change in attributes (Yuan per year).

Attribute	Marginal Value	*z*	*P* > |*z*|	[95% Conf. Interval]	For a 1% Improvement
ASC	−459	−2.29	0.0220	−852, −66	-
Farma	67	2.57	0.0100	16, 118	385
Farmf_1	174	2.03	0.0430	6, 342	-
Farmf_2	112	1.90	0.0580	−4, 229	-
Farmf_3	170	2.31	0.0210	26, 313	-
Waterq	34	3.13	0.0020	13, 56	34
Airq_1	303	2.57	0.0100	72, 534	-
Airq_2	248	2.24	0.0250	31, 466	-
Airq_3	195	1.97	0.0480	1, 389	-
Species	8	2.01	0.0440	0, 16	199
Recv	75	2.03	0.0420	3, 147	4

Note: (1) Partworths listed in Table 6 are calculated at the mean values of socio-demographic variables. (2) Exchange rate from Yuan to US $ in December 2013 was 0.17.

However, the partworths derived are clearly dependent upon the units of measurement. Directly comparisons among attributes make no sense since every attribute has its own unit. For the continuous attributes of farm area, water quality, species and recreation value, comparisons among the partworths of different attributes are available after standardizing them. For the discrete variables of farm fertility and air quality, standardization is not appropriate. Comparison can only be done among the different levels of the attributes. Partworths of the different level of farm fertility indicate that respondents' willingness to pay for the farmf_1 and farmf_3 are almost the same, while paying less for farmf_2. As for the air quality, partworths of the higher level of air quality are higher (303, 248 and 195 Yuan for airq_1, airq_2 and airq_3, respectively).

In the final column the partworth associated with a 1% improvement in the attribute are reported for the continuous variables. These reveal that for every percent change, each family in Wuhan is willing to pay 385 Yuan annually for farmland area, followed by species richness (199 Yuan) and water quality (34 Yuan), recreational value holds the lowest WTP (4 Yuan).

Given the diversity in the marginal utility of cost, it is also of interest to identify partworths for segments of the sample. Table 8 reports partworths for that group with the smallest, significant, marginal utility (when *willingness* = 1, *savings* = 1).

Table 8. Partworths when *willingness* = 1, *savings* = 1 (Yuan per year).

Attribute	Marginal Value	*Z*	*P* > |*z*|	[95% Conf. Interval]	For a 1% Improvement
ASC	−616	−1.97	0.0460	−1229, −3	-
Farma	90	2.27	0.0240	12, 167	516
Farmf_1	233	1.86	0.0600	−13, 480	-
Farmf_2	151	1.72	0.0880	−21, 323	-
Farmf_3	228	2.09	0.0370	14, 441	-
Waterq	46	2.58	0.0100	11, 81	46
Airq_1	406	2.18	0.0290	41, 771	-
Airq_2	333	1.95	0.0530	−2, 668	-
Airq_3	262	1.73	0.0840	−35, 559	-
Species	11	1.96	0.0520	0, 21	216
Recv	100	1.91	0.0530	−3, 203	5

Note: 1 Exchange rate from Yuan to US $ in December, 2013 was 0.17.

Although increased, the values in Table 8 do not become too extreme for this group. Just like the results in Table 7, when respondents are in their smallest, significant, marginal utility, partworth for status quo is still negative, while are positive for the six attributes, but all of their significant levels change when comparing those in Table 7.

For the attributes that described in form of categorical variables, respondents' willingness to pay for the three improvement levels of farm fertility are 233, 151 and 228 Yuan, respectively, and 406, 333 and 262 Yuan for airq_1, airq_2 and airq_3, respectively.

For a 1% improvement in the attribute for the continuous variables, respondents are willing to pay 516 Yuan annually for farmland area, followed by species richness (216 Yuan) and water quality (46 Yuan); recreational value engenders the lowest WTP (5 Yuan).

Scenarios must be defined if we want to quantify the farmland non-market values based on respondents' WTP despite it is still controversial [45]. In this paper, the annual WTP of a typical household for the farmland non-market-values from the Status Quo to the greatest attribute level was calculated as approximately RMB 886 (USD 145.32) by adding the WTP of each attribute. Thus, the total WTP can be performed by multiplying per household's WTP by the total number of households in Wuhan of 2013 (2.0919 million). As a result, the annual total WTP for the farmland non-market values protection option with the greatest attribute level amounts to RMB 1853.42 million (USD 303.99 million), and RMB 6159.60 (USD 1010.28) per hectare.

6. Policy Implications and Conclusions

6.1. Policy Implications

This paper estimates the public heterogeneous preferences for farmland non-market values using the heteroscedastic conditional logit model as a case study of Wuhan, Central China, which makes contribution both to literature and policy implications.

First, this study contributes to the literature on estimation of the non-market value of farmland using choice modeling, and is one of the few farmland non-market valuation studies that have been undertaken to account for heterogeneity in the error variance using a heteroscedastic conditional logit model in China. It provides researchers with an alternative way to explain respondents' heterogeneous preference when latent class failed to classify the respondents into a series of segments that significantly different from each other.

Second, the expression of these non-market benefits in monetary terms can be used by policy makers to determine how farmland resources should be allocated amongst competing management priorities. In this study, farmland non-market values based on respondents' annual WTP achieved as RMB 1853.42 million (USD 303.99 million), which will be of fundamental importance to policy makers when making farmland conversion decisions, and help them find a balance between farmland protection and economic development.

Moreover, the estimation of respondents' WTP for farmland non-market attributes help government improve the farmland protection policies from attribute level, thus increase the efficiency of resource allocation for public spending on the specific attributes. An improvement in the level of attributes with higher weights can increase the utility of the public significantly, which are air quality and farmland fertility in the case of Wuhan study. Accordingly, these results can help local government design more differentiated farmland protection policies in the newly revised *Land Management Law* as well as the new round of land use planning to control the amount of farmland conversion. Specifically, more emphasizes should be put on increasing the content of organic matter of farmland to guarantee the food security and quality. Only in this way can we prevent further deterioration of air quality and farmland fertility, and achieve the goal of farmland protection on quality, quantity and ecology simultaneously.

Finally, the aggregation of partworths showed that public annual WTP for the farmland non-market values in Wuhan amounts to RMB 1853.42 million (USD 303.99 million); that is, RMB

6159.60 (USD 1010.28) per hectare, which is three times as much as the sum of the grain and seed subsidy criteria of Wuhan in 2013. That may partly explain the low efficiency of China's present farmland protection policy, which could be reformed better in the future.

6.2. Conclusions

By using the heteroscedastic conditional logit model of CE method, this study provides a number of insights into respondents' preference heterogeneity, and also show how respondents make trade-offs among different hypothetical outcomes that arise from farmland improvement options.

First, results show that respondents have realized the farmland non-market values in Wuhan has been decreasing during the last decade and have significantly positive willingness to preserve the farmland. The attribute that respondents put on the highest weight in this study is air quality, followed by farmland fertility, farmland area, water quality, species richness and recreational value.

Second, all the estimated coefficient of the seven attributes have the expected signs. The coefficient for the ASC is negative while coefficients for attributes are positive. In addition, there appears to be a systematic relationship between respondents' socio-demographic characteristics and their reactions to cost. Interactions show those who have willingness to choose the farmland improvement options and have no deposit in the bank are more sensitive to cost. In addition, results of the heteroscedastic conditional logistic regression indicate that respondents with higher income, are aware of the farmland non-market values and have willingness to pay for it are more likely to choose the options after considered rather than randomly selected. Mean and most negative partworths of the attributes are also presented in this study, and partworths associated with a 1% improvement in the attribute are reported for the continuous variables, comparisons are made among those continuous attributes.

Third, the aggregation of partworths shows that per household's annual WTP for the farmland non-market value protection option with the greatest attribute level amounts to RMB 886 (USD 145.32) per household. The farmland non-market values achieves at RMB 1853.42 million (USD 303.99 million), which is RMB 6159.60 (USD 1010.28) per hectare.

Last but not least, respondents' willingness to pay for air quality in this study maybe overstated because data were collected at a time when there had been serious hazy weather in Wuhan, and respondents suffered much from the event. They are aware of this problem, and very sensitive to air management issues.

Acknowledgments: We are grateful to two anonymous referees for their useful comments on this paper. This study was supported the Fundamental Research Funds for the Central Universities of China (2662015QD024), Ministry of Education of the China Key Grant (14JZD009), and the National Natural Science Fund Foundation of China (71573101, 71573099, 41371519 and 71373095).

Author Contributions: Xin Yang and Anlu Zhang developed the concept and design of the study. Xin Yang and Yinying Cai collected and analyzed the data. Xin Yang and Michael Burton drafted the manuscript. Anlu Zhang and Michael Burton critically revised it. All authors read and approved the final manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Parr, J.; Papendick, R.; Hornick, S.; Meyer, R. Soil quality: Attributes and relationship to alternative and sustainable agriculture. *Am. J. Altern. Agric.* **1992**, *7*, 5–11. [CrossRef]
2. Lal, R. Managing world soils for food security and environmental quality. *Adv. Agron.* **2001**, *74*, 155–192.
3. Baerenklau, K.A. A latent class approach to modeling endogenous spatial sorting in zonal recreation demand models. *Land Econ.* **2010**, *86*, 800–816. [CrossRef]
4. Burton, M.; Rigby, D. Hurdle and latent class approaches to serial non-participation in choice models. *Environ. Resour. Econ.* **2009**, *42*, 211–226. [CrossRef]
5. Fenichel, E.P.; Lupi, F.; Hoehn, J.P.; Kaplowitz, M.D. Split-sample tests of "no opinion" responses in an attribute-based choice model. *Land Econ.* **2009**, *85*, 348–362. [CrossRef]

6. Louviere, J.; Street, D.; Carson, R.; Ainslie, A.; DeShazo, J.; Cameron, T.; Hensher, D.; Kohn, R.; Marley, T. Dissecting the random component of utility. *Market. Lett.* **2002**, *13*, 177–193. [CrossRef]
7. Louviere, J.J. What if consumer experiments impact variances as well as means? Response variability as a behavioral phenomenon. *J. Consum. Res.* **2001**, *28*, 506–511. [CrossRef]
8. Boxall, P.C.; Adamowicz, W.L. Understanding heterogeneous preferences in random utility models: A latent class approach. *Environ. Resour. Econ.* **2002**, *23*, 421–446. [CrossRef]
9. Jin, J.; Jiang, C.; Truong Dang, T.; Li, L. Public preferences for cultivated land protection in Wenling City, China: A choice experiment study. *Land Use Policy* **2013**, *30*, 337–343.
10. Polyakov, M.; Pannell, D.J.; Pandit, R.; Tapsuwan, S.; Park, G. Capitalized amenity value of native vegetation in a multifunctional rural landscape. *Am. J. Agric. Econ.* **2015**, *97*, 299–314. [CrossRef]
11. Jin, J.; Jiang, C.; Li, L. The economic valuation of cultivated land protection: A contingent valuation study in Wenling City, China. *Landsc. Urb. Plan.* **2013**, *119*, 158–164.
12. Bishop, R.C.; Heberlein, T.A. Measuring values of extramarket goods: Are indirect measures biased? *Am. J. Agric. Econ.* **1979**, *61*, 926–930. [CrossRef]
13. Aizaki, H.; Sato, K.; Osari, H. Contingent valuation approach in measuring the multifunctionality of agriculture and rural areas in Japan. *Paddy Water Environ.* **2006**, *4*, 217–222. [CrossRef]
14. Fausold, C.J.; Lilieholm, R.J. The economic value of open space: A review and synthesis. *Environ. Manag.* **1999**, *23*, 307–320. [CrossRef]
15. Grosjean, P.; Kontoleon, A. How Sustainable are Sustainable Development Programs? The Case of the Sloping Land Conversion Program in China. *World Dev.* **2009**, *37*, 268–285. [CrossRef]
16. Hensher, D.; Shore, N.; Train, K. Households' willingness to pay for water service attributes. *Environ. Resour. Econ.* **2005**, *32*, 509–531. [CrossRef]
17. Loomis, J.B.; González-Cabán, A. A willingness-to-pay function for protecting acres of spotted owl habitat from fire. *Ecol. Econ.* **1998**, *25*, 315–322. [CrossRef]
18. Pruckner, G.J. Agricultural landscape cultivation in Austria: An application of the CVM. *Eur. Rev. Agric. Econ.* **1995**, *22*, 173–190. [CrossRef]
19. Cai, Y.; Zhang, A. The Assessment of Non-Market Value of Agricultural Land Resource in Wuhan. *Resour. Sci.* **2006**, *6*, 104–111.
20. Boyle, K.J.; Özdemir, S. Convergent validity of attribute-based, choice questions in stated-preference studies. *Environ. Resour. Econ.* **2009**, *42*, 247–264. [CrossRef]
21. Streever, W.; Callaghan-Perry, M.; Searles, A.; Stevens, T.; Svoboda, P. Public attitudes and values for wetland conservation in New South Wales, Australia. *J. Environ. Manag.* **1998**, *54*, 1–14. [CrossRef]
22. Louviere, J.J.; Woodworth, G. Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. *J. Market. Res.* **1983**, *20*, 350–367. [CrossRef]
23. Ma, A.; Cai, Y.; Zhang, A. Cultivated Land Ecological Compensation: Based on Choice Experiments. *J. Nat. Resour.* **2012**, *27*, 1154–1163. (In Chinese).
24. García-Llorente, M.; Martín-López, B.; Nunes, P.A.L.D.; Castro, A.J.; Montes, C. A choice experiment study for land-use scenarios in semi-arid watershed environments. *J. Arid Environ.* **2012**, *87*, 219–230. [CrossRef]
25. Hanley, N.; Wright, R.E.; Alvarez-Farizo, B. Estimating the economic value of improvements in river ecology using choice experiments: An application to the water framework directive. *J. Environ. Manag.* **2006**, *78*, 183–193. [CrossRef] [PubMed]
26. James, S.; Burton, M. Consumer preferences for GM food and other attributes of the food system. *Aust. J. Agric. Resour. Econ.* **2003**, *47*, 501–518. [CrossRef]
27. Raguragavan, J.; Hailu, A.; Burton, M. Economic valuation of recreational fishing in Western Australia: statewide random utility modelling of fishing site choice behaviour. *Aust. J. Agric. Resour. Econ.* **2013**, *57*, 539–558. [CrossRef]
28. Travisi, C.M.; Nijkamp, P. Valuing environmental and health risk in agriculture: A choice experiment approach to pesticides in Italy. *Ecol. Econ.* **2008**, *67*, 598–607. [CrossRef]
29. Campbell, D. Willingness to Pay for Rural Landscape Improvements: Combining Mixed Logit and Random Effects Models. *J. Agric. Econ.* **2007**, *58*, 467–483. [CrossRef]
30. Duke, J.M.; Ilvento, T.W. A conjoint analysis of public preferences for agricultural land preservation. *Agric. Resour. Econ. Rev.* **2004**, *33*, 209–219.

31. Ozdemir, S. Convergent Validity of Conjoint Values for Farmland Conservation Easement Programs. Master's Thesis, The University of Maine, Orono, ME, USA, 2003.
32. Chen, Z.; Ju, D.; Zhang, A. Measuring external benefits of agricultural land preservation: Anapplication of choiceexperiment in Wuhan, China. *Acta Ecol. Sin.* **2013**, *33*, 3213–3221. [CrossRef]
33. Hole, A.R. Small-sample properties of tests for heteroscedasticity in the conditional logit model. *Econ. Bull.* **2006**, *3*, 1–14.
34. Lancaster, K.J. A new approach to consumer theory. *J. Political Econ.* **1966**, *74*, 132–157. [CrossRef]
35. Hensher, D.A.; Rose, J.M.; Greene, W.H. *Applied Choice Analysis: A Primer*; Cambridge University Press: Cambridge, UK, 2005.
36. Distante, R. *Heterogeneity and Relative Concerns*; Brunel University: London, UK, 2008.
37. DeShazo, J.; Fermo, G. Designing choice sets for stated preference methods: The effects of complexity on choice consistency. *J. Environ. Econ. Manag.* **2002**, *44*, 123–143. [CrossRef]
38. Li, M.; Wu, J.; Deng, X. Identifying Drivers of Land Use Change in China: A Spatial Multinomial Logit Model Analysis. *Land Econ.* **2013**, *89*, 632–654. [CrossRef]
39. Hao, F.; Chang, Y.; Ning, D. Assessment of China's economic loss resulting from the degradation of agricultural land in the end of 20th century. *J. Environ. Sci.* **2004**, *16*, 199–203.
40. Rozelle, S.; Veeck, G.; Huang, J. The Impact of Environmental Degradation on Grain Production in China, 1975–1990. *Econ. Geogr.* **1997**, *73*, 44–66. [CrossRef]
41. Li, W.; Feng, T.; Hao, J. The evolving concepts of land administration in China: Cultivated land protection perspective. *Land Use Policy* **2009**, *26*, 262–272. [CrossRef]
42. Wang, J.; Huang, J.; Rozelle, S. Evolution of tubewell ownership and production in the North China Plain. *Aust. J. Agric. Resour. Econ.* **2005**, *49*, 177–195. [CrossRef]
43. Caussade, S.; Ortúzar, J.D.; Rizzi, L.I.; Hensher, D.A. Assessing the influence of design dimensions on stated choice experiment estimates. *Transp. Res. B* **2005**, *39*, 621–640. [CrossRef]
44. Scheaffer, R.; Mendenhall, W., III; Ott, R.; Gerow, K. *Elementary Survey Sampling*; Cengage Learning: Puchong, Malaysia, 2011.
45. Bateman, I.J.; Day, B.H.; Georgiou, S.; Lake, I. The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. *Ecol. Econ.* **2006**, *60*, 450–460. [CrossRef]