Estimating Non-Market Environmental Benefits of the Conversion of Cropland to Forest and Grassland Program: a choice modeling approach[Φ]

Xuehong Wang and Jeff Bennett[1]

Paper presented at the 50th Annual Conference of the
Australian Agricultural and Resource Economics Society
8th – 10th February 2006, Sydney

Abstract

The non-use values of the environmental benefits derived from the Conversion of Cropland to Forest and Grassland Program in the Loess Plateau region were estimated using a choice modeling survey both on-site in Xi'an and Ansai and off-site in Beijing. Separate choice models were estimated for the three sites and the results compared. No significant differences were found for the implicit price estimates derived from the multinomial logit (MNL) model, the nested logit (NL) model and the random parameter logit (RPL) model for each data set and across all the samples. Based on the results from the MNL models, the estimates of values for the environmental improvements provided by the Program among the sampled urban households are statistically the same across the three places.

Key Words: choice modelling, environmental benefits, China

1. Introduction

Sustainable land use management offers opportunities for economic gain alongside ecological and social benefits. The growing intensity of ecological deterioration and consequent economic losses caused mainly by land and water degradation in the North West part of China aroused great public concern among the Chinese community in recent years and triggered the adoption of a new land use management strategy by the Chinese Government in 1999. The Conversion of Cropland to Forest and Grassland Program (CCFGP), initiated on a trial basis in 1999 and formally launched

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[1] PhD student and Professor respectively, Asia Pacific School of Economics and Government, The Australian National University. Email: xuehong.wang@anu.edu.au, jeff.bennett@anu.edu.au.

The authors wish to acknowledge the assistance of China National Forest Economics Development and Research Centre, Shaanxi Forestry Department, Chinese Academy of Forestry and Chinese Academy of Sciences in the research work presented in this paper.

Φ Research presented in this paper is part of the ACIAR funded project ADP/2002/021 'Sustainable Land Use Change in the North West Provinces of China'.

in 2000, encompasses 25 provinces, has land improvement and the provision of environmental services as its top priority. It is essentially a public payment scheme for environmental services from private farmlands. Participating farmers are subsidized through government funding to grow trees and grass on land previously used for annual cropping in order to meet the growing demand of the Chinese community for a better living environment. With government funding for the CCFGP drawing to an end in the next few years, increasing attention has been devoted to the long-term sustainability of the land use changes triggered by the CCFGP.

Few attempts have been made to devise innovative ways to sustain the finance required for the CCFGP during the period when the government funding stops until alternative livelihood sources for participating farmers become available and financially viable. For instance, the potential to have the Chinese communities who are the beneficiaries of the environmental improvements provided by the CCFGP to pay directly for their gains remains largely unexplored. This is, in part, because of a lack of information about the monetary values of the environmental benefits derived from the CCFGP. While some of these values can be inferred through market transactions – such as more fish production due to water quality improvement – other values, especially the non-use values of these environmental improvements cannot be estimated in similar ways. This research aims to fill this information gap by estimating the non-use values that the wider Chinese community place on the environmental benefits derived from the CCFGP where no market or related market data are available. Because the estimation involves non-use values, a stated preference technique is applied.

The most commonly used stated preference methods include the contingent valuation method (CVM) and the choice modeling (CM) technique. While the CVM can provide useful information about the value of environmental changes in aggregate, it cannot adequately estimate the values of the components that make up an aggregate environmental change. In many cases, an approach that focuses on values at a disaggregated level is preferred from a policy perspective. In CM, researchers can break down environmental changes into relevant 'attributes' and estimate values for those attributes. This allows increased flexibility in analysis (Garrod and Willis 1999). The tradeoffs among attributes identified in a CM analysis make it possible to expand policy options to include non-monetary compensation (Adamowicz *et al* 1998). CM results also have the flexibility to allow for the benefit transfer process to proceed more readily (Bennett and Blamey 2001). In addition, CM has the potential to reduce problems of framing bias because substitution effects can be incorporated within the questionnaire design (Bennett and Blamey 2001). Because some of these advantages are particularly important to the CCFGP policy context, CM has been applied in this research. The research results shed light on the future policy orientation of the CCFGP.

This paper is structured as follows. In the next section, details of the case study in this

CM application are presented. Methodologies adopted are briefed in Section 3. This is followed by a description of the application of the methodology in Section 4. Model specifications are detailed in Section 5. Results derived from the selected models, including people's willingness to pay for specific environmental attributes and the compensating surplus for changes under the CCFGP are demonstrated in Section 6. This paper concludes with a summary of the main conclusions and a discussion of the policy implications of the results in Section 7.

2. Case Study

The case reported in this paper involves the Loess Plateau, one of the most ecologically fragile areas in China. This is the area where the pilot phase of the CCFGP was implemented. The Loess Plateau lies in the north and central west of China, in the middle reaches of the Yellow River. It has an arid to semi-arid climate and covers large parts of Gansu, Shaanxi, Shanxi Provinces and the Ningxia Autonomous Region. It also covers parts of Qinghai and Henan provinces and the Inner Mongolia Autonomous Region (McVicar 2002; Sun and Zhu 1995). Having an area of 630,000 sq km, it is a heavily dissected landscape consisting of unique loess hills, sand-loess hills and loess tableland, with many gullies (Sun and Zhu 1995).

The Loess Plateau is considered to be the largest heavily erodable area on earth (Peng 2001). With the low proportion of vegetation cover, harsh winters and intense summer monsoon rainfall, soil erosion has become a severe problem on the Loess Plateau. The Chinese Academy of Sciences estimated that a total of 2.2 billion tons of topsoil are washed away every year on the Loess Plateau, with 70 per cent flowing into the Yellow River (Huang 2000). This equals an average of 1.6 billion tons of sediment being carried each year by the Yellow River. The Loess Plateau is the source of about 90 per cent of all the sediment that enters into the Yellow River (Douglous 1989 and Wan and Wang 1994 cited in Hessel 2002). Heavy sedimentation contributes to major flooding risks in the lower reaches of the Yellow River. Other off-sites effects include increasingly frequent sandstorm events with decreasing air quality, water quality deterioration affecting drinking water supplies, deteriorating landscapes and a loss of biodiversity (PTFDSSD 2003).

This study aims to model the hypothetical environmental choice behavior of Chinese urban people who are the downstream beneficiaries of the environmental improvements arising from the land use changes on the Loess Plateau under the CCFGP. Because these changes are predicted to have far-reaching environmental impacts extending to the coastal area in the east, the people considered to be beneficiaries are both 'on-site' and 'off-site'. On-site beneficiaries are defined as those people living on the Loess Plateau whilst off-site beneficiaries are defined to be limited to those living in North China. North China is defined as the land territory lying to the north of the Yangtze River. Environmental attributes defined as contributing to the non-use values derived from the CCFGP are briefed in Section 4 of this paper[2]. The CM methodology used to estimate the values involved is outlined in the next section.

3. The Choice Modeling Technique

The choice modelling technique (CM) is applied here to determine how people in the Chinese communities living downstream construct preferences for the environmental goods and services derived from CCFGP. CM is consistent with Lancaster's theory of consumer choice in which consumption choices are determined by the utility or value that is derived from attributes of a particular good or situation (Lancaster 1966). It is also based on the behavioural framework of random utility theory (RUT), which describes discrete choices in a utility maximising framework. Utility is assumed to be comprised of two parts:

$$U_i = V_i + \varepsilon_i \qquad (1)$$

where V_i is the systematic and observable component of the latent utility for option *i*; and ε_i is the random or "unexplained" component (Bennett and Blamey 2001).

Because of the random component, the researcher can never expect to predict preferences perfectly. This leads to expressions for the probability of choice:

$$P(i) = P[(V_i + \varepsilon_i) > (V_j + \varepsilon_j)] \qquad (2)$$

for all *j* options in the choice set. Different assumptions of the distribution of the random error terms yield different models. Assuming that the random error terms are distributed independently and identically (IID) and follow the Gumbel distribution with scale parameter μ (which is typically assumed to equal one), the probability of choosing option *i* can be estimated using the multinomial logit (MNL) model:

$$P(i) = \frac{\exp \mu V_i}{\sum_{j \in C} \exp \mu V_j} \qquad (3)$$

The IID error term assumption underpinning the MNL model implies a number of restrictions, in particular, the property of independence of irrelevant alternatives (IIA). The nested logit (NL) model represents a partial relaxation of the IID assumption of the MNL model. It recognizes the possibility of different variances across the alternatives and correlation among partitions of alternatives. For a detailed discussion of the NL model, please refer to Louvier *et al* (2000), Hensher *et al* (2005), and Champ *et al* (2003). The mixed logit model, or the random parameter logit (RPL) model represents a full relaxation of the assumption of IID. It allows model parameters to vary randomly over individuals. The probability is estimated as a 'mixture' of logits with the mixing distribution. The form of the RPL model is detailed in Revelt and Train (1998), Revelt and Train (1999), and Brownstone and Train (1999).

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[2] Further details of the environmental attributes can be found in Research Report No. 4 of the ACIAR funded project 'Sustainable Land Use Change in the North West Provinces of China' (ADP/2002/021) at http://www.apseg.anu.edu.au/staff/jb_suslndrr.php.

These model forms can be used to generate probabilities of choice and estimates of marginal value changes for each attribute and the compensating surplus (CS) for changes between different choice profiles (Bennett and Blamey 2001). Both the implicit price and the compensating surplus estimates can be used for testing the equivalence of different models and for benefit transfer to other case studies (Rolfe and Windle 2005; Morrison and Bennett 2000).

4. Choice Modelling Applications

4.1 Survey and questionnaire design

To test if people living proximate to the environmental impacts of concern have greater value than those who live further away, the same CM questionnaire[3] was used in surveying local residents in Ansai on the Loess Plateau, Xi'an which is the capital of Shaanxi Province, as well as residents from Beijing, the national capital, who live at a distance from the area involved in land use change under the CCFGP. All these three places are located in North China but have different social and economic characteristics. Using the same questionnaire affords an analysis of how estimates of value are influenced by respondent's distance from the site of the environmental impacts. Results from these three sub-populations can also be used to infer the value held by the wider Chinese urban community in the North.

The development of the survey questionnaire involved two rounds of focus groups. The questionnaire was preliminarily developed using the results from the first round of two focus groups held in Beijing in December 2004. Attributes that frame the change to be valued were initially defined through those two focus groups. They covered air quality, landscape, water quality and biodiversity. The attribute levels were specified based on scientific research done in the area and projections made by experts from the Chinese Academy of Sciences and Chinese Academy of Forestry (see ACIAR ADP/2002/021 Research Report No. 4 for details). The attributes and their levels are set out Table 1. Four more focus groups were held in July 2005 in Beijing, Xi'an and Ansai to confirm the earlier identified attributes and to refine the draft questionnaire. The clarity and presentation of information in the questionnaire, cognitive burden and confusion as well as perceived bias of information were also tested in these focus groups. Some noticeable changes to the draft questionnaire over the course of the focus groups include the selection of payment vehicle, the level of payment and the use and definition of the water quality attribute. Since most of the focus group participants did not like the idea of being charged with an ecological tax, alternative wording was used for the payment vehicle in the questionnaire: a compulsory payment to participating farmers. A maximum annual payment of 200 China Yuan Renminbi (CNY)[4] was suggested by focus group participants to replace

[3] Copies of questionnaire are available upon request.

[4] 1.00 CNY = 0.124000 USD (China Internet Information Centre 2006).

the earlier identified level (CNY 50). It was also found that water quality described in terms of sediment discharge into the Yellow River was more relevant to participants compared to alternative descriptors such as suitability for recreation or agriculture.

Table 1 Levels of Attributes

Attribute	Base Level	Alternative Levels
Payment per annum (CNY)*	0	50, 100, 200
Sandstorm days per year	22	20, 18, 16
Landscape (vegetation cover)	10%	20%, 30%, 40%
Water quality (billion tons of annual sediment discharge)	100% (1.9)	10% less, 15% less, 25% less
Plant species present	1600	1900, 2200, 2400

* annual payment for 10 years

Once the attributes and their levels were determined, an experimental design was developed to produce the choice sets for the CM questionnaire. An experimental design provides the various combinations of attribute levels. An orthogonal fractional factorial was used to allow the estimation of all main effects of the attributes. A main effect is the effect of an attribute change on utility regardless of the levels of the other attributes of that choice option (Bennett and Blamey 2001). It has been argued that the main effects typically account for 70 to 90 per cent of explained variance (Louviere *et al* 2000). Dominant alternatives or implausible alternatives were removed after the fractional factorial design was completed but orthogonality was preserved. The experimental design generated 25 choice sets and these were allocated to five blocks of five choice sets. Therefore there were five versions of the survey questionnaire differing only in the choice questions. One-on-one interviews were conducted to pre-test the revised survey questionnaire.

In the questionnaire, respondents were told that there were two broad options available for land use management on the Loess Plateau: to revert to the pre-CCFGP land use practices; and to continue the land use practices under the CCFGP. The scenario presented to respondents was that the financial support from the government in implementing the CCFGP will cease in 2007. This would mean that farmers may revert to previous land use practices because of their subsequent income losses. To keep farmers growing trees and grass on the Loess Plateau, financial support for the farmers involved in the Program was stated to be needed for 10 years beyond 2007. Specifically, a compulsory annual payment from urban households across China for a 10-year period would be required under this scenario. The size of the payment was stated to depend on the extent of the environmental improvements that the CCFGP aims to achieve on the Loess Plateau.

Respondents were then presented with five choice sets showing various options for land use management in the Loess Plateau region (see Figure 1 for an example). The options in the choice sets were defined using five different attributes: amount of annual compulsory payment, sandstorm days per annum, landscape in terms of vegetation cover, water quality described as annual sediment discharge, and plant species present. Respondents were asked for their preferred choice from each of the five sets of questions. They were also reminded of their available income and all other things they have to spend money when deciding on the preferred options. The different attribute levels used in the study are shown in Table 1.

Figure 1 Example of a choice set from the *Land Use Management on the Loess Plateau* questionnaire

	Option 1 (Reversion to land use practices pre-CCFGP) By 2020:	Continuation of CCFGP	
		Option 2 By 2020:	Option 3 By 2020：
Payment to farmers per annum (CNY)	0	100	100
Sandstorm days per year	22 days	20 days	18 days
Landscape (vegetation cover)	10%	30%	20%
Water quality (annual sediment discharge)	1.9 billion tons	15% less than Option 1	10% less than Option 1
Plant species present	1600 species	1900 species	2200 species
I would choose Tick one box only	☐ 1	☐ 2	☐ 3

4.2 Survey method and logistics

Empirical studies of goods with a large passive use value component have verified that only a small percentage of the aggregate economic benefit is accounted for by the people in the immediate jurisdiction where the good is located (Champ *et al* 2003: 64). The environmental benefits resulting from the land use change under the CCFGP on the Loess Plateau can be both on-site and off-site, and the associated non-market use and non-use value will accrue to people in both the North West provinces and elsewhere. The population of interest in this research context is the urban residents in North China. The definition of urban resident needs to be carefully drawn as the former distinction between urban and rural residents based on their "*hu kou*" (household register) no longer holds. Many rural people now live and work in urban cities without an urban "*hu kou*". According to the occupation-based social stratification completed by CASS (2004), rural people who have been living and working in urban cities for four to five years no longer belong to the social class of farmers but instead fall into other categories based on their new occupations. This principle applies to this survey. Furthermore, household rather than individual values are elicited in this survey.

Ideally, stratified random sampling based on occupation should be adopted. According to CAAS (2004), in the past 20 years, social stratification in China is more and more reflected by occupation stratification. This gives a true picture of the heterogeneity of the dynamic contemporary Chinese society. Even though theory suggests that WTP is closely related to income, stratification directly based on income levels may not work well in the Chinese context because people's true income levels are not reflected in official statistics. This is mainly due to the lack of a well-established tax system in China during the transition period and it is difficult to track the "implicit" income that people have. On the other hand, income can be inferred by people's occupations. Hence stratification based on occupation could ensure that the sample is representative in terms of income. To adopt the occupation-based stratified random sampling, a full list of people from each occupation is needed to set up the sample frame for each stratum. However, there is no such a list for some occupation groups. Therefore, a mixture of sampling methods was used for this research.

To meet the requirement of statistical testing for the choice models, a target of 600 households was set to be interviewed in Beijing, Xi'an and Ansai, with 200 households in each sub-sample. The occupation-based social structure is homogenous across different geographical districts in the urban areas in Beijing and Xi'an. Because of this, the geographical boundaries of the Third Ring Road in Beijing and the Second Ring Road in Xi'an were set as the limits of the survey area. This enabled travel cost savings of the in-person survey and also ensured that rural residents were excluded. In the next stage, systematic sampling was adopted to select five blocks each from the 15 blocks within the Third Ring Road in Beijing and from the 16 blocks within the Second Ring Road in Xi'an. Quota sampling against occupation and systematic sampling in terms of the households approached within each block were then applied in combination. About 40 households were drawn randomly from each geographical block, with the specific number of households drawn from each occupation group in proportion to the percentage of the population as a whole in the respective cities (Table 2). Because there are five versions of the CM survey questionnaire distinguished by five different blocks of choice sets, this sampling strategy ensures that each version was taken by 40 respondents in each of the five geographical blocks with respondents from different occupation groups being involved evenly. Altogether 200 valid questionnaires were collected in Beijing and 203 questionnaires in Xi'an.

Table 2 Sub-sample Occupation Groupings: Beijing and Xi'an

Occupation Stratification	**Percentage of Residents (%)**		**Number of People Surveyed**		**Percentage of the Sample (%)**	
	Beijing	**Xi'an**	**Beijing**	**Xi'an**	**Beijing**	**Xi'an**
Senior Government Employee (division director level and above)	5	3	10	6	5	3
Senior Manager	5	3	10	6	5	3
Private Entrepreneur	2.6	2.1	5	4	2.5	2
Professional and Technician	20	20	40	40	20	20
Clerk (in governments, manufacturing sectors and companies)	20	20	40	40	20	20
Small Business Owner	6.1	11.5	12	23	6	11.5
Employee in the Commercial and Service Sectors	20	16.1	40	32	20	16
Worker/ labour	20	20	40	40	20	20
Unemployed (including those being re-employed temporarily)	1.3	4.3	3	9	1.5	4.5
Total	100	100	200	200	100	100

Sources: Adapted from Beijing Statistics Bureau 2004 and 2005 and Xi'an Statistics Bureau 2004; China Business Times 2004; Chinese Academy of Social Sciences 2004.

Quota sampling based on occupations was not used in Ansai given its small urban population of around 17,000 and its lower population heterogeneity. All the residential buildings in the urban area of Ansai are within walking distance, so four geographical blocks were stratified first and systematic sampling was then applied in approaching the households living in each block. Because the urban area of Ansai is home for both the urban population and rural population, a screening question was asked to identify urban respondents. Altogether 203 valid survey questionnaires were collected.

4.3 Socio-demographics of respondents

The socio-demographics of the respondents and the population average in Beijing, Xi'an and Ansai are shown in Table 3. Across the three sub-samples, the age structure of the samples is close to the city/ town average. The sex structure of the sample in Beijing is close to the city average, but is not representative in Xi'an and Ansai. This is because the survey was mainly conducted at people's homes, and in most cases the male is the decision-maker in the households. Both the education and income characteristics of the sub-samples are different from the populations in each of the three places. The difference in education can be explained by the inclusion in the city/ town average of both urban and rural residents who generally have lower average educational levels than urban residents, which are the target group of this survey. The lower income level of the sample does not present a problem, as an earlier argument in the survey method section demonstrates that stratification based on occupation can fully ensure that the sample is representative of the population in terms of income. The lower income level is also partly due to the fact that people normally do not like to reveal their true incomes.

Table 3 Socio-demographics of the respondents

Variable	**BEIJING**		**XI'AN**		**ANSAI**	
	Sample average	Beijing average	Sample average	Xi'an average	Sample average	Ansai average
Age (>18 years)	39.6	42.1	39.4	41.5	36.6	39.5
Sex (% male)	56.3	52.3	70.4	52.0	62.6	52.5
Education (% > year 12)	40.5	28.6	40.9	20.4	37.0	24.4
Income (CNY)	9906.3	15637.8	4973.5	8544.0	5673.3	9407.0

Sources: China National Statistics Bureau 2000 Census data; Beijing Statistics Bureau 2004 and 2005; Xi'an Statistics Bureau 2004 and 2005; Shaanxi Statistics Bureau 2004 and 2005.

5. Model Specification

5.1 Logistics for Model Specification

The choice data were analysed using the LIMDEP software program. With the sub-samples separated, three data sets emerge. MNL, NL and RPL models were estimated for each data set. In the following subsections, model specifications by different model forms for each data set are reported. Interpretations of model results are briefly discussed. Variables used in these models and their coding are specified in Table 4.

Table 4 Variables used in the Choice Models

Variable	Description
Attribute Variable	
Cost	Amount that households would pay each year as a compulsory payment to farmers for a duration of 10 years (payment vehicle)
Sandstorms	Number of sandstorm days each year
Landscape	% of vegetation cover on the Loess Plateau
Water quality	% of current sedimentation level in the Yellow River
Plant species	Number of plant species present in the Loess Plateau region
ASC	Alternative-specific constant taking on a value of 1 for options 2 and 3 in the choice sets, and 0 for the base option
ASC1	Alternative specific constant used in nested logit models taking on a value of 1 for option 2 in the choice sets, and 0 for the base option
Non-attribute Variable	
Age	Age of respondent (in years)
Income	Income of households in RMB yuan
Job	Job groupings taking on a value of 1 for white-collar jobs and 0 for blue-collar jobs
Education	Education level taking on a value of 1 for those of tertiary or higher level, and 0 otherwise
Support	Attitude towards the payment vehicle taking on a value of 1 if respondents support the payment vehicle, and 0 otherwise
Devatt	Dummy variable taking on a value of 1 for respondents indicating that, over the years, when have heard about proposed conflicts between development and the environment, they have tended to 'Favor economic development'; 0 otherwise
Visit*	Previous visit to the Loess Plateau taking on a value of 1 if there is, and 0 otherwise

* This variable is only applicable to the Beijing and Xi'an data, since Ansai is located on the Loess Plateau.

5.2 The Multinomial Logit (MNL) Models

Initially standard MNL models were estimated for each data set. Two different MNL models were estimated for each of the places using the data from the survey. The first is a basic model that shows the importance of the choice set attributes in explaining respondents' choices across the three different options: 'do nothing' and revert to land use practices pre-CCFGP (option 1), and 'do something' and continue with the CCFGP (options 2 and 3). The second model includes both socio-demographic and attitudinal variables in addition to the attributes in the choice sets. The results for these models are shown in Table 5. Since the models are based on three data sets, the coefficient estimates are not directly comparable across the samples. However, the significant level of the attributes and the socio-demographic and attitude characteristics that affect people's choices can be compared across the three places.

Table 5 Multinomial logit model results

VARIABLE	BEIJING Model 1	BEIJING Model 2	XI'AN Model 1	XI'AN Model 2	ANSAI Model 1	ANSAI Model 2
ASC	0.3098	0.5442**	1.1914***	2.1724***	0.1651	1.3408**
	(-0.2825)	(0.4747)	(0.2808)	(0.5090)	(0.2809)	(0.5617)
COST	-0.0042***	-0.0035***	-0.0077***	-0.0081***	-0.0073***	-0.0066***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
SANDSTORMS	-0.0808***	-0.0918***	0.0027	-0.0071	-0.0439	-0.0463
	(0.0291)	(0.0306)	(0.0290)	(0.0298)	(0.0292)	(0.0297)
LANDSCAPE	0.0190**	0.0153***	0.0065	0.0107*	0.0287***	0.0276***
	(0.0056)	(0.0059)	(0.0056)	(0.0058)	(0.0058)	(0.0058)
WATER QUALITY	-0.0045	-0.0041	-0.0202***	-0.0179**	-0.0151**	-0.0162**
	(0.0071)	(0.0075)	(0.0072)	(0.0073)	(0.0072)	(0.0074)
PLANT SPECIES	0.0013***	0.0012***	0.0006***	0.0006**	0.0008***	0.0007***
	(0.0002)	(0.0002)	(0.0002)	0.0002	(0.0002)	(0.0002)
ASC*INCOME		0.0000***		0.0000*		0.0001***
		(0.0000)		(0.0000)		(0.0000)
ASC*AGE		-0.0447***		-0.0551***		-0.0347***
		(0.0085)		(0.0086)		(0.0084)
ASC*SUPPORT		1.3840***		1.6979***		2.3024***
		(0.2494)		(0.2203)		(0.2283)
ASC*VISIT		-0.5981**				
		(0.2639)				
ASC*JOB		0.6156**				
		(0.2554)				
ASC*EDUCATION				0.6600***		
				(0.2339)		
ASC*DEVATT				-1.2593***		-1.8951***
				(0.3434)		(0.3418)
ASC*SEX						0.9518***
						(0.1972)
Summary Statistics						
Log-likelihood	-926.3654	-781.7293	-957.2196	-863.5011	-993.072	-871.527
Pseudo-R^2	0.03637	0.0955	0.05577	0.1276	0.0578	0.1711
Observations	1000	910	1015	990	1015	1015

Notes:

Standard deviation in parentheses; The number of observations in Beijing Model 2 is 910 and in Xi'an Model 2 is 990 which excludes those saying 'don't know' about their income level; *denotes significance at 10% level, **denotes significance at 5% level, and ***denotes significance at 1% level.

These models reveal that in general respondents have a preference for less payment, fewer sandstorm days, a landscape with more vegetation coverage, better water quality in terms of less sedimentation content, and more plant species. The WATER QUALITY attribute in the Beijing models and the SANDSTORMS attribute in the Xi'an and Ansai models are insignificant, indicating that these environmental attributes did not influence the selection of options among respondents in the respective places. The insignificant sign of the SANDSTORMS attribute in Xi'an and Ansai contradicts *a priori* expectations that sandstorms might be more of a concern to people in the North West who suffer more from sandstorms than to people in Beijing. The LANDSCAPE attribute in Xi'an Model 2 becomes significant at the 10 per cent level by including respondents' heterogeneity. The sign of the ASC indicates a positive preference for the 'change' scenario across the three places. Although the model fit all improves for Model 2 across the three data sets, the pseudo-R^2 remains low, especially for the Beijing and Xi'an data.

The models show that across the three places, respondents' incomes, ages and whether they agreed with the compulsory payment made to farmers have impacts on their choices. Some of these effects are consistent with expectations. Respondents were more likely to support the continuation of the land use change under the CCFGP if they have higher income and agreed with the compulsory payment made to farmers. Interacting the AGE variable with the ASC shows that older people are less likely to choose the change options.

Besides these common factors, there are other socio-demographic and attitude characteristics that affect people's choices yet differ across different places. Previous visit to the Loess Plateau and occupation have an impact on people's preferences in Beijing. The Beijing respondents who had been to the Loess Plateau before were more likely to choose the status quo. This reflects the focus group discussions, where some respondents considered the Loess Plateau to have a unique landscape that should be maintained as it was. Those who had a white-collar job were more likely to support the continuation of the land use change under the CCFGP in Beijing. Education level is a determinant of preferences among the Xi'an respondents. Those who received higher education at tertiary level or above were more likely to choose the 'change' options. In Ansai, female respondents were found to be more likely to choose the status quo compared to males. In addition, in Xi'an and Ansai, respondents who have a pro-development orientation were more likely to choose the status quo.

5.3 The Nested Logit (NL) Models

An attempt to perform a standard Hausman test for the IIA assumptions of the MNL models for the three data sets was not successful as the difference matrix was not positive definite. Nested logit models were accordingly explored for the three data sets to relax partially the IIA assumption. A nested structure was adopted where respondents were assumed to make an initial choice between "doing nothing" and "doing something". Initial choice at this branch level was made on the basis of attitudinal and socio-demographic variables. If respondents chose to "do something", they were then assumed to choose between Option 2 and Option 3 on the basis of the five attributes and associated levels presented in the choice sets. The NL model can also be used to test for the IIA assumption. An inclusive value (IV) parameter statistically equal to 1.0 indicates that the two branches should collapse into a single branch, which is equivalent to a MNL model. It also indicates there are small correlation structures between the utility functions of alternatives present within the lower level of the nest (Hensher *et al* 2005: 548-549). The results of the nested logit model specifications for the three data sets are shown in Table 6.

Table 6 Nested logit model results

VARIABLE	BEIJING		XI'AN		ANSAI	
	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error
Utility functions						
COST	-0.0038***	0.0009	-0.0085***	0.0009	-0.0065***	0.0008
SANDSTORMS	-0.1029***	0.0366	-0.0193	0.0337	-0.0395	0.0311
LANDSCAPE	0.0167***	0.0062	0.0119**	0.0062	0.0265***	0.0060
WATER QUALITY	-0.0072	0.0083	-0.0181**	0.0075	-0.0154**	0.0075
PLANT SPECIES	0.0012***	0.0002	0.0006***	0.0002	0.0007***	0.0002
ASC1	0.2085***	0.0740	-0.0004	0.0741	0.0628	0.0734
Branch choice equations						
ASC	0.4801	0.6164	1.9895***	0.6490	1.3441**	0.5830
ASC*SUPPORT	1.3817***	0.2498	1.6970***	0.2196	2.3034***	0.2294
ASC*AGE	-0.0451***	0.0085	-0.0541***	0.0086	-0.0348***	0.0084
ASC*VISIT	-0.5917**	0.2641				
ASC*INCOME	0.0001***	0.0000	0.0000***	0.0000	0.0000***	0.0000
ASC*JOB	0.6120**	0.2561				
ASC*DEVATT			-1.2243***	0.3450	-1.9346***	0.3461
ASC*EDUCATION			0.6445***	0.2335		
ASC*SEX					0.9654***	0.1989
Inclusive value parameters						
DO NOTHING	1.0000	0.0000	1.0000	0.0000	1.0000	0.0000
DO SOMETHING	0.8268*	0.4807	0.7500***	0.2843	1.2293***	0.3308
Model Statistics						
Log-likelihood	-777.6984		-863.0171		-870.8408	
Pseudo-R^2	0.3441		0.3178		0.3147	
Observations	2730		2985		3045	

Notes: *denotes significance at the 10% level; **denotes significance at 5% level; and ***denotes significance at 1% level.

The branch choice equations indicate the relative utility of 'doing something' versus 'doing nothing'. The socio-demographic and attitudinal variables that were significant in determining how respondents made the initial choice between 'doing nothing' and 'doing something' are the same as those in the MNL models, with the same signs and very similar magnitude as indicated by the coefficients and the level of significance. Allowing for differential variation in the unobserved effects across partitions of alternatives improves the model fit. Even so, the log likelihood ratio tests show that the NL and MNL models are statistically the same for Xi'an and Ansai. For the Beijing sample, the NL model is significantly superior to the MNL Model.

The choice between options 2 and 3 is modeled as shown under the heading 'Utility functions' in Table 6. Compared to the result of MNL model 2, the attributes in the respective NL model all have the same signs and the attribute coefficients are of similar magnitudes. While the levels of significance of these attributes remain the same in the Beijing and Ansai NL models, they differ in the Xi'an NL model. The level of significance for LANDSCAPE and PLANT SPECIES in the Xi'an NL model is higher compared to the MNL model. The inclusive value (IV) parameter for the 'doing nothing' partition is constrained at 1.0 as it is a degenerate partition, while the IV parameter for the 'doing something' partition is left free to be estimated. The IV parameter for the 'doing something' partition is found to be not significantly different from one in the Beijing and Xi'an NL models. This indicates that there is little correlation between options 2 and 3 and the conclusion can be made that the IIA property is satisfied in the Beijing and Xi'an MNL model.

The IV parameter in the Ansai NL model is greater than 1.0 which needs further investigation. The inclusive value parameter is the ratio of the scale parameter at the upper level to the scale parameter at the lower level, and the scale parameter is inversely related to the standard deviation. Hence the IV parameter should be in the range of 0~1.0 due to the presence of greater variance in the upper-level error components which include the variance components from both the lower-level choices and upper-level choices (Louviere *et al* 2000: 146). The IV parameter estimate in the Ansai case suggests that an increase in the utility associated with option 2 or 3 would lead to an increase in probability of choosing option 1, which is not consistent with the random utility model. It suggests that the nesting structure should be questioned and the related NL results should be interpreted with caution.

5.4 The Random Parameter Logit (RPL) Models

To relax fully the IIA assumptions and account for the possibility of heterogeneity in taste parameters and correlated choice situations for the same individual, random parameter logit models were explored. RPL models can be used to compare the parameter estimates with those from the MNL and NL models. In this research, individual-specific or *conditional* mean parameter estimates (i.e. common-choice-specific parameter estimates conditioned on the choices observed within the data) are estimated.

A distribution for the random parameters needs to be specified and parameters are estimated for that distribution. In most applications, normal and lognormal distributions are specified (Train 2003). The lognormal distribution is useful when a coefficient is known to have the same sign for everyone (Train 2003). Brownstone and Train (1999), Train (1998) and Layton (1999) used a lognormal distribution for the coefficient of cost to constrain it to be negative. Other applications assume a normal distribution for the cost coefficient (Garrod *et al* 2002; Rigby and Burton 2003). While restricting preferences to be positive or negative is a useful property, the long tail generated in practice when estimating models of this form generates infeasible ranges of parameter values and WTPs (Rigby and Burton 2003). In this study, it is assumed that the random parameters are distributed normally and hence no constraints on their signs are set. The normal distribution offers the option of indifference for a potentially large portion of the population. Following Revelt and Train (1998), the cost coefficient in this study is fixed while other coefficients are allowed to vary. This makes it convenient to interpret the model as the WTP for each attribute is thereby distributed in the same way as the attribute's coefficient.

Initially heterogeneity around the mean population parameter was determined through the estimation of a standard deviation parameter associated with each random parameter estimate. Attributes which consistently show an insignificant standard deviation over the range of draws were then re-estimated as having fixed coefficients. This reduces the computational complexity for a large number of random parameters. Estimates were obtained using 500 random draws to simulate the sample likelihood. The results of the RPL model specifications for the three data sets are shown in Table 7.

Table 7 Random parameter logit model results

VARIABLE	BEIJING		XI'AN		ANSAI	
	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error
Random Parameters						
SANDSTORMS *(Mean)*	-0.1064	0.0987	-0.2514*	0.1493	-0.0435	0.1099
LANDSCPAE *(Mean)*			0.0040	0.023		
WATER QUALITY *(Mean)*					0.0631**	0.0317
Non-random Parameters						
ASC	0.9958**	0.4191	2.6303***	0.6178	1.1286**	0.5674
COST	-0.0039***	0.0009	-0.0104***	0.0012	-0.0072***	0.0009
LANDSCAPE	0.0143**	0.0065			0.0284***	0.0063
WATER QUALITY	-0.0077	0.0085	-0.0263***	0.0091		
PLANT SPECIES	0.0015***	0.0003	0.0006**	0.0003	0.0009***	0.0003
Heterogeneity around the Mean						
SANDSTORM: SUPPORT	-0.3203***	0.0704			-0.1697***	0.0646
SANDSTORM: AGE	0.0081***	0.0022			0.0060**	0.0025
SANDSTORM: JOB	-0.2311***	0.0632			-0.1246**	0.0656
WATER QUALITY: SUPPORT					-0.0983***	0.0240
WATER QUALITY: AGE					0.0006	0.0006
WATER QUALITY: JOB					-0.0450***	0.0187
SANDSTORM: SUPPORT			-0.2341***	0.0806		
SANDSTORM: AGE			0.0128***	0.0036		
SANDSTORM: EDUCATION			-0.2014***	0.0757		
LANDSCAPE: SUPPORT			0.039***	0.0131		
LANDSCAPE: AGE			-0.0005	0.0005		
LANDSCAPE: EDUCATION			0.0101	0.0119		
SANDSTORMS *(Std. Dev.)*	0.3677***	0.1172	0.4660***	0.1258	0.1678	0.1269
LANDSCAPE *(Std. Dev.)*			0.0317	0.0287		
WATER QUALITY *(Std. Dev)*					0.0677**	0.0325
Model Statistics						
Log-likelihood	-804.6309		-867.4771		-905.7998	
Pseudo-R^2	0.19071		0.1967		0.1821	
Observations	2730		2985		3045	

Notes: *denotes significance at the 10% level; **denotes significance at the 5% level; and ***denotes significance at the 1% level; Standard deviation in parentheses.

The random parameters that are identified for the three data sets include the SANDSTORMS attribute for the Beijing model, SANDSTORMS and LANDSCAPE for the Xi'an model, and SANDSTORMS and WATER QUALITY for the Ansai model. The ASC and PLANT SPECIES remain non-random parameters in the three RPL models, indicating that respondents in each of the three places show general consensus regarding these attributes, and that in general people prefer the 'change' scenario. To determine the possible sources of heterogeneity around the mean of the random parameters, the random parameters are interacted with other socio-demographic variables.

For the Beijing sample, accounting for heterogeneity and correlation of the RPL model leads to an improvement in model fit compared to the MNL models, with the pseudo-R^2 value reaching 19 per cent. This partly explains why the Beijing MNL model has a low explanatory power even with most of its attribute coefficients being significant at the 1 per cent level. The MNL model failed to capture the heterogeneity around the mean of the SANDSTORMS attribute. The estimates of the SANDSTORM attribute in the Beijing RPL model are well dispersed, indicating that there is a diversity of opinion, ranging from deep concern to indifference, and this leads to imprecise estimates of the average population preference of sandstorm days. The inclusion of socio-demographics shows that respondents' age, job, and whether they support the idea of compulsory payment all significantly impact their preferences of sandstorm days. Even with the inclusion of respondent characteristics, the standard deviation is still large and significant, indicating that people's preference for sandstorm days varies more than is captured by these characteristics. There may be other observable characteristics that relate to the variation and this reflects the limited nature of the socio-demographic information that was available from the survey data. One possibility arises based on the focus group discussions where some people believed that sandstorms in Beijing were mainly caused by land degradation in the upper northern Mongolian region rather than the Loess Plateau. Taken together, the insignificant mean of the SANDSTORMS parameter and the significant and fairly large standard deviation imply that SANDSTORMS do affect people's choices: the mean is not significantly different from zero because the different tastes regarding sandstorms tend to balance out in the population. Again, the attribute of WATER QUALITY has no impact on choices in the RPL model. This is consistent with the MNL model results.

Compared to the MNL models, the Xi'an RPL model shows an improvement in model fit with the pseudo-R^2 value approaching 20 per cent. The comparison also reveals some changes in the significance level of the attributes. The LANDSCAPE attribute becomes insignificant while the SANDSTORMS attribute becomes significant at the 10 per cent level in the RPL model. Both the estimate of the mean and the standard deviation of LANDSCAPE are not significantly different from zero. Possible sources of the heterogeneity that may exist around the mean of LANDSCAPE could not be explained by interacting with socio-demographics variables. This indicates that the attribute of LANDSCAPE has no impact on choices in the RPL model. The inclusion of socio-demographics shows that respondents' age, educational level, and whether they support the idea of compulsory payment all significantly impact their preferences of SANDSTORMS. However, considerable variation remains after including socio-demographic variables, indicating that tastes vary considerably more than can be explained by observed characteristics of people. Even though the mean of the SANDSTORMS parameter is significant at the 10 per cent level, the presence of heterogeneity over the sampled population may suggest a single parameter estimate is insufficient to represent all sampled individuals.

The Ansai RPL model does not show much improvement in model fit compared to MNL Model 2, with a pseudo-R^2 value of 18 per cent. SANDSTORMS and WATER QUALITY are the two attributes that have great variation. With the inclusion of respondent characteristics, the standard deviation of SANDSTORMS becomes insignificant, indicating that the variation of respondents' preferences for sandstorm days is captured by these characteristics. Respondents' age, job, and whether they support the idea of compulsory payment all significantly impact their preferences of sandstorm days. However, the estimate of the mean of SANDSTORMS is not significantly different from zero. This indicates that the attribute of SANDSTORMS has no impact on choices in the RPL model, which is in line with the MNL and NL model results. The standard deviation for WATER QUALITY remains significant after including socio-demographic characteristics. Respondents' job and whether they support the idea of compulsory payment significantly impact their preferences for water quality. However, respondents' preference for water quality varies more than is captured by these characteristics. Even though the mean of the WATER QUALITY parameter is significant at the 5 per cent level, the presence of heterogeneity over the sampled population may suggest that a single parameter estimate is insufficient to represent all sampled individuals. This can be justified by the positive sign of the WATER QUALITY coefficient implying that respondents are willing to pay some amount of money to have more sediment discharge into the Yellow River, which is against theory and intuition.

6. Comparative Results and Discussion

6.1 A Comparison of Model Results: *MNL and RPL*

In this study, the MNL, NL and RPL models were estimated for each of the three data sets. The log likelihood ratio tests show that the MNL Model 2 is not significantly different from the NL model for both the Xi'an and Ansai data. Even though the NL model is statistically superior to the MNL Model 2 for the Beijing data, the implicit prices calculated from the two models are not significantly different. Therefore, only the results from the MNL Model 2 and the RPL model are presented in this section for comparison. Estimates of implicit prices derived from these models for each data set are displayed in Table 8. These implicit prices relate to the annual payments respondents indicated they were willing to pay for environmental improvements. The payments were to be made for a period of ten years.

Note that the implicit prices from the RPL models are derived from the estimate of the mean of the distribution for the random parameters and do not reflect the whole distribution. Therefore, only some crude comparisons of implicit price estimates can be made across the models. Confidence intervals for the implicit prices are calculated using the Krinsky and Robb (1986) procedure. A vector of 1000 sets of parameters is drawn for each model to re-estimate the welfare changes. A Poe *et al* (2001) test was followed to assess whether there are significant differences between the implicit prices derived from the MNL and RPL models.

Table 8 Mean Annual Implicit Prices (IP) and Confidence Intervals (95% level)

	Beijing Models		Xi'an Models		Ansai Models	
	MNL	**RPL**	**MNL**	**RPL**	**MNL**	**RPL**
Sandstorms	**-27.75** (-52.99 ~ -9.6)	**<u>-28.78</u>** (-88.14 ~ 23.45)	**<u>-1.01</u>** (-8.22 ~ 6.44)	**<u>-24.11</u>** (-55.58 ~ 4.53)	**<u>-7.28</u>** (-16.34 ~ 1.72)	**<u>-5.49</u>** (-36.09 ~ 24.00)
Landscape	**4.62** (1.29~9.30)	**3.74** (0.09~7.90)	**1.34** (0.02~2.74)	**<u>0.29</u>** (-3.59 ~ 4.39)	**4.26** (2.49~6.21)	**3.98** (2.19~6.24)
Water Quality	**<u>-1.28</u>** (-6.05 ~2.94)	**<u>-1.98</u>** (-6.48 ~ 2.43)	**-2.24** (-4.11 ~ -0.58)	**-2.58** (-4.29 ~ -0.83)	**-2.52** (-4.88 ~ -0.38)	**<u>8.65</u>** (-0.41 ~ 17.73)
Plant Species	**0.36** (0.19~0.64)	**0.41** (0.23~0.75)	**0.07** (0.02~0.13)	**0.06** (0.00~0.11)	**0.11** (0.04~0.19)	**0.13** (0.06~0.21)

Note: "_" denotes those IPs that are not significantly different from zero at the 95% level; CIs in parentheses; the mean IPs reported in this table are calculated using the Krinsky and Robb (1986) procedure.

As Table 8 shows, the MNL and RPL models generate annual implicit prices for all attributes that are not significantly different from each other across all the samples. Furthermore the annual implicit price for SANDSTORMS is not significantly different from zero in all places surveyed apart from in the Beijing MNL model. The annual implicit price for WATER QUALITY is not significantly different from zero in Beijing and in the RPL model for Ansai respondents.

6.2 A Comparison of Annual Implicit Prices: *Beijing vs Xi'an vs Ansai*

In making the comparison of the annual implicit prices that respondents in different places put on each environmental attribute, the MNL model results are used. Justification of the choice of the MNL models for further analysis can be made on the following grounds. First, even though the explanatory power of the Beijing and Xi'an RPL models is higher than their MNL counterparts because both RPL models capture the heterogeneity of respondents' preferences of SANDSTORMS, the mean coefficients for SANDSTORMS in these models are not sufficient to present all sampled individuals as shown in Table 8. The pseudo-R^2 in the Ansai RPL model does not show much improvement compared to the MNL model, and moreover the coefficient for the WATER QUALITY attribute is not significant in the RPL model. In addition, the implicit price estimates are not significantly different between the MNL and RPL models across all the samples.

Second, the *conditional* mean parameter estimates derived from the RPL models in this research are for each sampled individual. That is, only the tastes of sampled individuals can be determined. While these individual parameter estimates are scientifically rigorous, the use of these estimates means that any output generated is limited to within the sample (Hensher *et al* 2005). This makes prediction outside of the sample difficult. In this case estimates from the MNL models may be better predictors of population behavioural reactions to policy changes.

Third, even thought the MNL models involve the IIA restrictions, this research has found that the IIA property is satisfied in the Beijing and Xi'an MNL models through the estimation of the NL models. Table 9 demonstrates the annual implicit prices for each environmental attribute and the present value of the aggregated amount over a 10-year period calculated using the discount rates of 3 per cent, 10 per cent and 20 per cent. Because respondents were asked to make the payment from 2007 in the survey, the present values at the 2007 level are then further discounted to the present values at the 2006 level.

Table 9 Present Value of Implicit Prices (in CNY) and Confidence Intervals (95%)

	Beijing		**Xi'an**		**Ansai**	
	Implicit Price	**CI**	**Implicit Price**	**CI**	**Implicit Price**	**CI**
Sandstorms	**-27.75**	**-52.99 ~ -9.6**	-1.01*	-8.22 ~ 6.44	-7.28*	-16.34 ~1.72
3%	-229.82	-438.85~ -79.5	0	0	0	0
10%	-215.19	-410.92~ -74.45	0	0	0	0
20%	-197.26	-376.68~ -68.24	0	0	0	0
Landscape	**4.62**	**1.29~9.30**	**1.34**	**0.02~2.74**	**4.26**	**2.49~6.21**
3%	38.26	10.68~77.02	11.10	0.17~22.69	35.28	20.62~51.43
10%	35.83	10.00~72.12	10.39	0.16~21.25	33.04	19.31~48.16
20%	32.84	9.19~66.11	9.53	0.14~19.48	30.28	17.70~44.14
Water Quality	-1.28*	-6.05 ~2.94	**-2.24**	**-4.11 ~ -0.58**	**-2.52**	**-4.88 ~ -0.38**
3%	0	0	-18.55	-34.04~ -4.80	-20.87	-40.41~ -3.15
10%	0	0	-17.37	-31.87~ -4.50	-19.54	-37.84~ -2.95
20%	0	0	-15.92	-29.22~ -4.12	-17.91	-34.69~ -2.70
Plant Species	**0.36**	**0.19~0.64**	**0.07**	**0.02~0.13**	**0.11**	**0.04~0.19**
3%	2.98	1.57~5.30	0.58	0.17~1.08	0.91	0.33~1.57
10%	2.79	1.47~4.96	0.54	0.16~1.01	0.85	0.31~1.47
20%	2.56	1.35~4.55	0.50	0.14~0.92	0.78	0.28~1.35

As Table 9 shows, for a decrease in one sandstorm day, respondents in Beijing on average are willing to pay CNY 229.82 over a 10-year period at the discount rate of 3 per cent. The implicit price for SANDSTORMS is insignificant among the Xi'an and Ansai respondents, indicating it has no value to them. This is against *a priori* expectation that sandstorm days may be of more concern to people in Xi'an and Ansai as they are located on the Loess Plateau and suffer more from sandstorms.

The implicit price for landscape improvement is statistically the same among respondents across the three places. For one per cent higher vegetation cover, respondents in Beijing on average are willing to pay CNY 38.26 over a 10-year period at 3 per cent discount rate and the average WTP of Ansai respondents is CNY 35.28. The average WTP that Xi'an respondents hold for landscape improvement totals CNY 11.10 for a 10-year period. This amount is not significantly different from that elicited by Beijing and Ansai respondents.

The implicit price for WATER QUALITY is not significantly different from zero in the Beijing model. This indicates that sediment discharge into the Yellow River is not a concern to respondents in Beijing who live thousands of kilometers away from the sandy area. In contrast, Xi'an and Ansai are located in the Loess Plateau region and people suffer directly from the poor water quality with high sediment content. The implicit price for WATER QUALITY is statistically the same among the Xi'an and Ansai respondents. For one per cent less sediment content in the Yellow River, on average respondents in Xi'an are willing to pay CNY 18.55 for a 10-year period at the discount rate of 3 percent and the average WTP of Ansai respondents is CNY 20.87.

The implicit price for PLANT SPECIES is significantly different from zero in all of the models, indicating a common concern over biodiversity protection across respondents in the three places. The implicit prices are not significantly different among respondents in the three places. Because of the large number of plant species involved in the estimation, the implicit price for every single plant species is relatively low. On average respondents are willing to pay CNY 0.58 – 2.98 over the 10-year period for the protection of every single plant species.

6.3 Compensating Surplus

The implicit price estimates show that in general respondents in Beijing, Xi'an and Ansai have a WTP for environmental improvement on the Loess Plateau under the CCFGP. Once the implicit price for each attribute is available, different combination of the attributes that are used to describe alternatives can be evaluated. These alternatives can be considered as the outcomes of different management options. In this study, the compensating surplus for each household, which is the overall WTP for a change from the status quo under the CCFGP, is calculated based on the estimates derived from the MNL models. The compensating surplus results will be integrated into a cost-benefit analysis. The status quo (reversion to land use practices pre-CCFGP) and the change (continuation of CCFGP) scenarios are projected as follows based on biophysical predictions of attribute levels outlined in previous studies (see ACIAR ADP/2002/021 Research Report No. 4):

Status quo scenario: There will be an average of 22 sandstorm days per year, 9.6 per cent of vegetation cover, 1637 plant species on the Loess Plateau and 1.9 billion tons of sediment in the Yellow River by 2020.
Change Scenario: There will be an average of 16 sandstorm days per year, 40 per cent of vegetation cover, 2386 plant species on the Loess Plateau and 1.4 billion tons of sediment in the Yellow River by 2020.

Estimates of compensating surplus are calculated using the following equation:

$$CS = -\frac{1}{\beta_M}(V_0 - V_1)$$

where β_M is the marginal utility of income (assumed to be equal to the coefficient of the monetary attribute); V_0 represents the utility of the status quo and V_1 represents the utility of the change scenario.

Using this equation, WTP at the household level for a change from the status quo under the CCFGP in the three sub-sample locations is calculated. The WTP values elicited in the survey were annual payments to be paid over a 10-year period, hence the present value of the aggregated amount is calculated using a range of discount rates at 3 per cent, 10 per cent and 20 per cent. These are shown in Table 10. If a 3 per cent discount rate is applied, the present value (in 2006) of the average WTP per respondent household for the environmental improvement under the CCFGP for a 10-year period will total CNY 6033.50 (USD 748.43) in Beijing, CNY 3454.90 (USD 428.57) in Xi'an and CNY 3959.59 (USD 491.17) in Ansai. Even at a discount rate as high as 20 per cent, there is still a WTP among sampled households for improved environment under the CCFGP ranging from CNY 1457 to CNY 2545 (USD 180-316) for a 10-year period.

Table 10 Estimates of household willingness to pay (in CNY and USD) and Confidence Intervals (95% level)

		BEIJING		XI'AN		ANSAI	
		CNY	**USD**	**CNY**	**USD**	**CNY**	**USD**
Household WTP per annum		728.53 (429.14~1221.38)	90.37 (53.23~151.51)	417.17 (303.95~555.65)	51.75 (37.71~68.93)	478.11 (323.06~673.81)	59.31 (40.07~83.58)
Total WTP For 10 years	**3%**	6033.50 (3554.03~10115.16)	748.43 (440.87~1254.75)	3454.90 (2517.24~4601.75)	428.57 (312.26~570.83)	3959.59 (2675.50~5580.33)	491.17 (331.89~692.22)
	10%	4069.55 (2397.16~6822.59)	504.84 (297.37~846.37)	2330.30 (1697.86~3103.84)	289.07 (210.61~385.02)	2670.71 (1804.60~3763.88)	331.29 (223.85~466.90)
	20%	2545.28 (1499.30~4267.17)	315.75 (185.99~529.36)	1457.48 (1061.92~1941.29)	180.80 (131.73~240.81)	1670.39 (1128.68~2354.11)	207.21 (140.01~291.93)

These per household estimates can be aggregated to determine the WTP of the wider community to achieve the environmental improvement under the CCFGP as described in the 'change' scenario. The implicit prices for the attributes can also be used to value a range of other scenarios resulting from different land use management options. The non-use values estimated from these different scenarios are suitable for inclusion in a benefit-cost analysis framework to determine which scenarios are likely to have the greatest net benefits for the community.

6.4 Method of Provision

An issue that has been further explored is the impact of the method of provision on value estimates. In this study, the method of provision is the mechanism by which CCFGP will continue to be implemented, which is a 10-year compulsory payment made to participating farmers by urban households. It has been argued that in some cases the method of provision engenders protest responses that obscure respondents' true values for empirical estimation (Champ *et al* 2003: 128-129). During the survey, some respondents explicitly objected to the proposed policy mechanism, suggesting that it should be the Government's responsibility to finance the continuous implementation of the CCFGP. To test whether the method of provision had an impact on welfare estimates, another set of MNL models were estimated in which people who strongly objected to the idea of compulsory payment were excluded. Results in Table 11 show that except for WATER QUALITY in Xi'an, the implicit prices derived from these models are higher than those from the previous MNL models without exclusion. This shows that the method of provision did have an impact on welfare estimates. Respondents have a higher WTP for the environmental improvement under the CCFGP which had been obscured by the proposed policy mechanism.

Table 11 Comparison of Annual Implicit Prices with and without Exclusion (CNY)

	BEIJING		**XI'AN**		**ANSAI**	
	Without Exclusion	**With Exclusion**	**Without Exclusion**	**With Exclusion**	**Without Exclusion**	**With Exclusion**
Sandstorms	-26.23	-40.28	-0.88*	-3.12*	-7.02*	-3.25*
Landscape	4.37	5.37	1.32	2.06	4.18	4.92
Water Quality	-1.17*	-2.09*	-2.21	-2.02	-2.45	-3.61
Plant Species	0.34	0.38	0.07	0.08	0.11	0.11

*denotes the attributes which are not significant.

7. Conclusions

The implementation of the CCFGP provides a mix of market and non-market environmental goods and services. Even though there is a 'missing' or an 'incomplete' market for the non-market goods and services, they contribute positively to human wellbeing and warrant inclusion in policy analyses of alternatives. In this study, these non-market values especially the non-use values derived from the CCFGP were estimated using the choice modeling technique. Respondents' preferences for the environmental improvements under the CCFGP were elicited in a household survey and their choice behavior was then modeled to infer their WTP for environmental improvements. Different choice models were estimated in this study to simulate outcomes that can be used in policy analysis or as components of decision support tools.

It has been found that there is substantial non-market WTP among the surveyed Chinese urban community for various changing environmental conditions under the CCFGP. The annual household WTP is about 1.8 per cent, 1.4 per cent and 1.7 per cent respectively of the household income in Beijing, Xi'an and Ansai[5]. The finding

[5] The calculation is based on the average per capita annual income in Table 3 and the number of people in the households. There is an average of 2.69 persons per household in Beijing, 3.4 persons in Xi'an and 3 persons in Ansai (Beijing Statistics Bureau 2004 and 2005; Xi'an Statistics Bureau 2004 and 2005; Ansai Statistics Bureau 2004 and 2005).

of a WTP among sampled households contradicts conclusions drawn by an earlier study which was one of the few studies of the market for environmental services in China. The study, initiated by the International Institute for Environment and Development (IIED), found that factors limiting WTP for environmental services in China include a low environmental awareness and low ability to pay among the others (Lu *et al* 2002). However, their study acknowledged that the analysis was restricted by a lack of published material. Based on our study, the demand-side constraints for environmental services in China identified by the IIED study do not hold. Throughout the focus groups discussions and the formal survey, respondents consistently showed concerns for environmental issues. The amount of WTP among the beneficiaries indicates that the Chinese people have some ability to pay for the environmental services.

The findings of this research also show that environmental issues in China are no longer considered to be local issues only. People living both on-site and off-site of the Loess Plateau are concerned about its land use management and consequent environmental impacts. The WTP for an improved environment transcends local boundaries. Furthermore the results suggest that there is no distance decay effect on the non-use values from the implementation of the CCFGP on the Loess Plateau. This study has found that even though respondents in Beijing are thousands of kilometers away from the Loess Plateau, they have an equivalent WTP for the environmental improvement on the Plateau as respondents in Xi'an and Ansai. A further implication is that the non-use values in this study are more decided by respondents' socio-demographic characteristics such as their income level. The average income level of the Beijing sample is almost twice as much as that of Xi'an and Ansai samples. The average income level of Xi'an and Ansai samples is similar, and respondents' WTP in these two places is also of similar magnitude. This is consistent with findings from the MNL model based on the aggregate data of the three places (i.e. when the three sub-samples are combined) showing that respondents' income level has a highly significant effect on their preferences. It has also been found that respondents' preference for the method of provision has an impact on the level of non-use values. The non-use values become higher when respondents who objected to the compulsory payment were excluded in the analysis.

Respondents in each of the three sub-samples elicit general consensus regarding biodiversity conservation in terms of plant species present. However, respondents have shown various levels of indifference and heterogeneity with regards to the other three attributes. There are a number of possible reasons for this. First, people in different locations might have different environmental concerns. For instance, water quality in terms of sediment content is found to be of concern to people in Xi'an and Ansai, but is of less concern to people in Beijing. Second, people in different locations might have different levels of familiarity with the issue at hand, leading to different interpretation of the information and framing of the issue. For example, it was found during the survey that people in Ansai have a better understanding of the land use management issue on the Loess Plateau and the implementation of the CCFGP compared to people in Xi'an and Beijing. In this study, RPL models were estimated to capture the heterogeneity of respondents' preferences for different environmental attributes.

The non-use values estimated in this study will be extrapolated to the relevant population and the result integrated into a cost-benefit analysis framework. The continuation of the CCFGP can be assessed by comparing the benefits derived from the Program with the costs of implementing the Program with the non-use environmental values being an important component of the benefits. The non-use value estimates also have implications for targeting downstream beneficiaries of the environmental benefits derived from the CCFGP as one source within a multi-options financing strategy for the continuation of the Program when the government subsidies stop. In addition, the information can be used to assist in policy design in other policy settings. For instance, the value estimates could help decision-makers to prioritize land use management options and favor those attributes that have higher implicit prices.

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