INCORPORATING UNCERTAINTY AND CERO VALUES INTO THE VALUATION OF PROTECTED AREAS AND SPECIES

Jesús Barreiro Hurlé, Jose María Casado García and Luis Pérez y Pérez
IFAPA - Junta de Andalucía, London School of Economics, CITA - Gobierno de Aragón
jesus.barreiro.ext@juntadeandalucia.es

Poster prepared for presentation at the XI Annual Congress of the EAAE (European Association of Agricultural Economists), 'The Future of Rural Europe in the Global Agri-Food System' Copenhagen, Denmark, August 24-27, 2005

INCORPORATING UNCERTAINTY AND CERO VALUES INTO THE VALUATION OF PROTECTED AREAS AND SPECIES[1]

Abstract

Under the Spanish conservation law, compensation is envisaged for the damage associated with all actions that reduce the quantity or quality of protected areas and species. This paper provides a tool to evaluate the monetary equivalent of this damage. We conduct a contingent valuation exercise to estimate the existence value related to protected areas and species in Aragon. This estimate is then reconsidered including the possibility of zero bids and also the possibility of uncertain preferences for non-familiar goods. Considering these two effects, mean values are reduced significantly giving support to previous recommendations of dividing by two contingent valuation estimates from dichotomous choice question formats.

Key Words: Natural heritage; contingent valuation; Spike model; uncertainty

JEL Clasiffication: B23, C24, C42, C52, D62, Q26.

I.- Introduction

Under the Spanish conservation law, compensation is envisaged for the damage associated with all actions that reduce the quantity or quality of protected areas and species (PAS). Compensation should cover the welfare loss that society suffers when an element of PAS is destroyed. Managing authorities when determining fines that should be imposed to those who affect PAS face the difficult task of valuing PAS' non-market functions. The most common approach taken in Spain to value this is either to impose administrative prices or use values that under estimate total welfare loss. This implies that the dissuasive nature of this fines envisaged in the Law for Conservation of Natural Protected Areas and Wildlife is partially lost.

This paper develops a tool that allows for the estimation of the non-market functions' value in a simple and straightforward way, thus avoiding the lack of relationship between the welfare effect resulting from destruction of PAS and the fine imposed. The tool chosen is contingent valuation with an aggregate valuation design for all PAS in one region. This avoids the possible complementarity and substitution effects between individual elements of PAS that could arise when valuing each element in isolation. Additionally, the valuation design includes an no-payment option and considers the effect of uncertain preferences following the proposal of Berrens et al. (2002) and Li and Mattson (1995). Willingness to pay is estimated following four alternative approaches: a) Hanemann (1984), b) Cameron and James (1986), c) Kriström (1990) and d) Li and Matson (1995). This allows us to test the effects of uncertainty in preferences regarding PAS and presence of out of market individuals on the values obtained.

II.- Theoretical framework

Utility versus price in non-market valuation

Hanemann (1984) analysing dichotomous choice contingent valuation considers yes/no answers to an offered bid as an approximation to welfare maximization, where two alternative results are confronted to the person surveyed. On the other hand, Cameron and James (1986)

[1] This research has been funded by the Department of the Environment of the Regional Government of Aragon. Views expressed herein are those of the authors and do not necessarily represent those of the funding institution.

develop a maximum likelihood procedure to estimate WTP which assumes that individual provide yes/no answers when their real WTP is higher (lower) than the proposed bid. This models provides more flexibility and the truncation level is considered as the latent variable in contrast with the previous ones where the offered bid was considered as an exogenous variable. This model considers that if the monetary value of an improvement caused by a resource is higher than the posted bid, individual will be willing to pay.

The starting point for Hanemann (1984) is the indirect felicity function that can be specified as $U(j,\lambda;S)$; where j=0 represents the initial level of a good and j=1 represents the state of this same good in another moment in time, λ is the individual's rent and S is a vector of individual's socio-economic variables. As individual preferences are unknown, however the utility can be considered a random variable expressed as:

$$U(j,\lambda;S) = V(j,\lambda;S) + \varepsilon_j \qquad j = 0,1 \tag{1}$$

Where $V(j,\gamma;S)$ is the mean of the random variable and ε_0 y ε_1 are independent and identically distributed random variables with cero mean. If the researcher offers the bid P to individual, he is going to accept it if:

$$V(0,\lambda - P;S) + \varepsilon_0 \geq V(1,\lambda;S) + \varepsilon_1 \tag{2}$$

With a probability distribution function that can be expressed as:

$$\begin{aligned} P_0 &= \Pr\{PayP\} = \Pr\left(V(0,\lambda - P,S) + \varepsilon_0 \geq V(1,\lambda,S) + \varepsilon_1\right) = \Pr(\varepsilon_1 - \varepsilon_0 \leq \Delta V) = F_\tau(\Delta V) \\ P_1 &= \Pr\{NotPayP\} = 1 - P_0 \end{aligned} \tag{3}$$

Where ΔV is the utility differential between moment 0 and 1, $\tau = \varepsilon_1 - \varepsilon_0$ and $F_\tau(\bullet)$ is the distribution function of τ. If an individual is willing to pay P $(\Delta V \geq \tau)$, then the equivalent surplus will be higher or equal to P, and:

$$F_\tau(\Delta V) = P_r(\Delta V \geq \tau) = P_r(E \geq P) = 1 - G_E(P) \tag{4}$$

Where $G_E(P)$ is the cumulative distribution function of individuals WTP.

This model can be estimated though MLH, and the logarithm can be written as

$$\log L = \sum_{i=1}^{n} \{I_i \log F_\tau(\Delta V_i) + (1 - I_i)\log[1 - F_\tau(\Delta V_i)]\} \tag{5}$$

Where $F_\tau(\Delta V_i)$ is the probability of a yes answer and I_i a count variable which takes value one when individuals answer yes to the WTP question and cero otherwise.

Cameron y James (1987), explicitly reject the connexion between utility and willingness to pay. Under their approach, contingent valuation survey data should be considered with out relying on linkages related to marginal utility using alternative models to those of traditional discrete choice ones. Their approach assumes that the continuous unobservable dependent variable are the true answers for WTP for a public good y_i and follows a logistic distribution, conditional on a vector of independent variables x_i $(i = 1,\ldots,N)$, with mean $x_i'\gamma$. Therefore, the valuation model can be expressed as:

$$y_i = x_i\gamma + u_i \quad (6)$$

While in the previous model p_i was included as one of the x_i independent variables, we now assume that yes/no answers correspond to WTP higher or lower than p_i, using the offered bids as latent variable.

$$I_i = 1 \text{ if } y_i > p_i\,;\;\; I_i = 0 \text{ (otherwise)} \quad (7)$$

and with the sequence of a traditional probit model we can optimised the following maximum likelihood function, using different types of iterative algorithms optimisation

$$LogL = \sum_{i=1}^{n} \left\{ I_i \log\Phi\left(-\frac{p_i - x_i\gamma)}{\sigma_u} \right) + (1 - I_i)\log\Phi\left(\frac{p_i - x_i\gamma)}{\sigma_u} \right) \right\} \quad (8)$$

Where Φ represents the cumulative distribution function of a standard normal variable.

In both models, the welfare change due to a change in conservation policies can be evaluated using the estimated parameters. Mean and median WTP are the most frequently used measures and their expression is reflected in Table 1.

Table 1. Welfare measures according to the different models.

Welfare measure	Hanemann (1984)	C. & J. (1986)
Mean	$C = E\{E\} = \int_0^{\infty} [1 - G_E(P)]dP - \int_{-\infty}^{0} [G_E(P)]dP$	$E(y_i / x_i) = \exp(x_i\gamma)\exp\left(\frac{\sigma_u^2}{2}\right)$
Median	$C' = \Pr\left[U(0, \gamma - P^d; S) \geq U(1, \gamma; S)\right] = 0.5$	$C' = \exp(x_i\gamma)$

Source: Hanemann (1984) and Cameron y James (1987).

The Spike Model

Markets for private goods consider that any individual paying for a good is "in the market", on the other hand those not purchasing the good have revealed that they are not willing to pay its price. Conventional contingent valuation studies, following dichotomous choice question formats under Hanemann (1984), assume that all individual are "in the market" for the public good considered and that all possess a positive WTP. Nevertheless, cero-consumption can be analysed taking into account whether individuals are in or outside the market. An individual is in the market if the offered bid is lower than his WTP. To solve this issue Kriström (1997) developed the Spike model which includes also individuals out-side the market and showing cero-WTP for a specific public good. Assigning non-cero probability to cero WTP causes an inflexion point in WTP distribution, which is useful when individual accepting the contingent market are scarce, or WTP distributions shows an asymmetric behaviour.

Taking into account these considerations, from (4) and that $P_0 = \Pr(DAP \geq P) = 1 - F_{DAP}(P) = F_\tau(AV)$ we can re-write the likelihood function incorporating the specificities of the Spike model.

$$\log L = \sum_{i=1}^{n} S_i I_i \log(1 - F_\tau(P)) + S_i(1 - I_i)\log[F_\tau(P) - F_\tau(0)] + (1 - S_i)\log(F_\tau(0)) \quad (9)$$

Where S_i =1 if the individual wants to contribute for the provision of the public good and S_i =0 otherwise. Additionally, I_i takes value one when the individual accepts the offered bid and cero otherwise. $F_\tau(P)$ distribution function must follow the following expression in order to consider individuals with cero WTP.

$$\begin{aligned} F_\tau(P) &= 0 \text{ If } P < 0 \\ F_\tau(P) &= \text{A If } P = 0 \\ F_\tau(P) &= G_\tau(P) \text{ If } P > 0 \end{aligned} \tag{10}$$

Where A takes values within the interval (0,1) and $G_\tau(P)$ is a monotonous growing function.

$$\begin{aligned} &G_\tau(0) = A \\ &\lim_{P\to\infty} G_\tau(P) = 1 \end{aligned} \tag{11}$$

Going back to (9), we can observer the three possible situations considered in the Spike model. First, individuals accepting the hypothetical market and with a WTP grater than the offered bid (P). Second, individuals rejecting the offered bid because is too high but accepting the hypothetical market and willing to contribute some amount. Last, the distribution function includes those individuals who reject the offered bid and would reject any other amount, as the offered good is not included in their utility function. Considering the general model, the mean can be estimated as:

$$C = E\{E\} = \int_0^\infty (1 - F_{DAP}(P))dP = \int_0^\infty \frac{e^{\alpha-\beta P}}{1+e^{\alpha-\beta P}} dP = \frac{1}{\beta}\lim_{P\to\infty}(-\log(1+e^{\alpha-\beta P}) + \log(1+e^{\alpha})) \tag{12}$$

If this integer is to converge β has to be greater than cero, implying that marginal utility of income has to be positive if mean WTP is to exist in a Spike model. If this is so, expression (12) can be simplified to

$$\frac{1}{\beta}\log\left[1+e^{\alpha}\right] \tag{13}$$

Median WTP will take the following value

$$\begin{aligned} &\frac{\alpha}{\beta} \quad \text{If } (1+e^{\alpha})^{-1} < 0.5 \\ &0 \quad \text{Otherwise} \end{aligned} \tag{14}$$

Last, we can determine the "Spike" for our distribution function; this will be the value for which probability of WTP will be cero.

$$F_{WTP}(0) = Spike = \frac{1}{1+e^{\alpha}} \tag{15}$$

Uncertainty and contingent valuation

The three models described previously assume that individuals posses a certain valuation for good j. If that were the case, valuation would be easier using open-ended question formats where full information would be recorded for individuals WTP. Several options have been proposed to include uncertainty in the analysis of dichotomous choice contingent valuation data. Li and Mattsson (1995), following the model proposed by Cameron and James (1987), and Cameron (1988), reconsidered by Patterson and Duffield (1991), introduce an additional question in contingent valuation surveys which records the variation in the probability of accepting or rejecting the offered bid. Alternatively, Dubourg *et al*. (1994, 1997) consider that uncertainty can be detected directly using a different question format. This question format offers a wide range of initial bids to each individual allowing them "don't know" answers for a chosen bid-interval. The amplitude of this interval is then considered as a proxy for uncertainty.

Following the same reasoning as in (6) and assuming the same hypothesis as in Cameron and James (1987) specified above but adopting a log-linear valuation function $\log(y_i) = x_i\gamma + \varepsilon_i$, where x_i is a vector with variables explaining individual *I*'s behaviour and ε_i a random component capturing omitted variables, the logarithm of the likelihood function is represented by,

$$LogL = \sum_{i=1}^{n}\left\{I_i \log\Phi\left(-\frac{(\log(p_i) - x_i\gamma)}{\sigma_\varepsilon}\right) + (1 - I_i)\log\Phi\left(\frac{(\log(p_i) - x_i\gamma)}{\sigma_\varepsilon}\right)\right\} \tag{16}$$

Where Φ represents the cumulative distribution function for a standard normal variable and I_i the response variable, which takes, value one if the individual accepts the offered bid and cero otherwise.

At this stage we introduce the hypothesis of uncertainty in individual preferences for the environmental good being considered. Therefore, additionally to the random component generated by omitted variables, stated preferences include another random component due to the lack of certainty in preferences. The first component generates a residual variance higher than that of a model with certain preferences, and WTP estimates will be overestimated. Our objective is to split both elements included in the random component, extracting the component generated by uncertainty in preferences and considering for WTP estimation only the component related to omitted variables.

Thus we adapt the previous model to our objective,

$$\log(\tilde{y}_i) = \log(y_i) + v_i \tag{17}$$

Where v_i is the random noise generated by individual's uncertainty and $\tilde{y}_i$ follows the same behavioural pattern as before. But in this case we acknowledge that his decision is influenced by an uncertainty component, v_i.

We can re-write [17] as:

$$\log(\tilde{y}_i) = x_i\gamma + e_i \tag{18}$$

Where, $e_i = \varepsilon_i + v_i$, represents the error composed both by an uncertainty component and the omitted variables. The distribution function would be now expressed as,

$$P_0 = \Pr(\log(\tilde{y}_i) \geq \log(p_i)) = \Pr(x_i\gamma + e_i \geq \log(p_i)) = \Pr(e_i \geq \log(p_i) - x_i\gamma)$$
$$P1 = 1 - P_0 \qquad (19)$$

Assuming the error term v_i follows a normal distribution with cero mean and constant variance σ_v^2, the logarithm of the likelihood function can be written as,

$$LogL = \sum_{i=1}^{n}\left\{ I_i \log\Phi\left(-\frac{(\log(p_i) - x_i\gamma)}{\sigma_e} \right) + (1 - I_i)\log\Phi\left(\frac{(\log(p_i) - x_i\gamma)}{\sigma_e} \right) \right\} \qquad (20)$$

Assuming that both components of the random noise are independent, we can consider that $\sigma_e = \sqrt{\sigma_\varepsilon^2 + \sigma_v^2}$, with $\sigma_e > \sigma_\varepsilon$, when $\sigma_v \neq 0$. Mean WTP can be expressed as $E(y_i / x_i) = \exp(x_i\gamma) * \exp\left(\frac{\sigma_e^2}{2} \right)$, and the overestimate can be expressed as $\exp\left(\frac{\sigma_v^2}{2} \right)$ units with regards to individuals true WTP.

In order to extract both components from the residual, Li and Mattsson (1995) propose a two step model in which the first step will estimate using maximum likelihood equation (20) where we can obtain in addition to coefficients the aggregated residual variance σ_e. To carry out the second step and additional question must be included in the questionnaire. This question must record information regarding the level of certainty[2] when answering the original dichotomous choice valuation question. In our case we have used a scale from 1 (not certain at all) to 10 (totally certain).

We understand this measure of certainty π_i as the subjective probability of individual's valuation being higher (for positive answers) or lower (for negative ones) than the offered bid. So,

$$\pi_i = P(\log(\tilde{y}) \geq \log(p_i)) = P(\log(y_i) + v_i \geq \log(p_i)) = 1 - \Phi\left[\frac{(\log(p_i) - \log(y_i))}{\sigma_v} \right] \qquad (21)$$

Replacing y_i and inverting Φ we obtain,

$$Z_i = \Phi_v^{-1}(1 - \pi_i) = \frac{(\log(p_i) - x_i\gamma)}{\sigma_v} - \frac{\varepsilon_i}{\sigma_v} \qquad (22)$$

Under this formulation and with $\delta_i = \frac{\varepsilon_i}{\sigma_v}$ the logarithm of the likelihood function can be specified as,

$$LogL = \sum_{i=1}^{n} Log\varphi\left(\frac{(\log(p_i) - x_i\gamma)/\sigma_v - z_i}{\sigma_\delta} \right) \qquad (23)$$

Where φ is the density function of a normal distribution and σ_δ, δ_i 's standard deviation. Maximizing (23) we can obtain γ, $\sigma_{v,}$ and σ_δ.

[2] The level of certainty (C_i) can be considered as the inverse of the level of uncertainty (UC_i) and UC defined as 1-C_i.

As we have assumed $\sigma_{\varepsilon} = \sqrt{\sigma_e^2 - \sigma_v^2}$, estimating (23) we can obtain not only the standard deviation estimated in (20) but also parameter estimates for γ more consistent than those provided by the conventional model.

A practical problem raised by expression (23) is that of the influence of marginal changes in probability on the normal cumulative distribution function inversion process. To solve this issue, Li and Mattsson consider the following censored likelihood function logarithm.

$$LogL = \sum_{i \in Q_z} Log\varphi\left[\frac{(h_i - z^0)}{\sigma_\delta}\right] + \sum_{i \in Q_0} Log\Phi\left[\frac{(h_i - z^0)}{\sigma_\delta}\right] + \sum_{i \in Q_1} Log\Phi\left[\frac{(h_i - z^1)}{\sigma_\delta}\right] \qquad (24)$$

Where $h_i = \frac{(\log(p_i) - x_i\gamma)}{\sigma_v}$ and Q_z , Q_0 and Q_1 represent the series $\{i / z^0 < z_i < z^1\}$, $\{i / z^i \leq z^0\}$, and $\{i / z^i \geq z^1\}$ respectively and z^0 and z^1 the upper and lower limits that bound z^i values. The logarithm of the likelihood function presented in (24) must be optimised using a truncated dependent variable procedure.

III.- Application: good description and questionnaire design

As mentioned above, we opted for an aggregated approach to obtain the estimate of PAS total value. This decision was taken for two main reasons. First, the overall number of PAS is quite high and individual PAS knowledge by society is diverse. Therefore, individual valuations could not be compared, specially if we take into account that the environmental functions towards global biodiversity carried out by each component can be considered as quite similar. Additionally, literature review of individual studies carried out in Spain and internationally shows that individual valuation can imply, in many cases, a double counting problem. Although values obtained for individual PAS do show sensibility to scope (Barreiro *et al*, 1998; Barreiro 1999a, Smith and Osborne, 1996), it is also true that aggregation of individual values do show some inconsistency. For example, prior studies in Aragon show that existence values for four protected areas amount for 40,5 € per year[3] while the existence value for all biodiversity in Navarra (a neighbouring region with similar characteristics but higher per capita income) has been estimated as 80 € per year (Elorrieta y Castellano, 1999). Brown and Shorgen (1998) detected a similar pattern in the USA where existence value for 18 endangered accounts for over 1% of GNP.

Once the valuation approach had been chosen, other questionnaire design issues had to be tackled. The questionnaire was discussed in focus groups of economics students at the University of Zaragoza to test for comprehension flaws and later delivered by market research company to a random pilot sample of 30 individuals. Feedback from both pre-tests was included in the final version of the questionnaire. The survey instrument begins with two questions related to the importance given by individuals to a series of public policies among which the environment was included and the importance of a series of environmental issues among which species extinction and habitat degradation were included. These two questions provide a frame for the good being valued and avoid importance bias, this bias was also prevented by introducing an statement in the introductory text mentioning that there were no “correct” on “incorrect” answers to the survey questions.

Next a series of questions were included to discover individual knowledge regarding the good being valued. Knowledge was elicited for the three components of natural heritage

[3] Barreiro (1999b), Pérez y Pérez *et al.* (1998), Rebolledo y Pérez y Pérez (1994) and EIN Aragón (2002).

considered: protected areas, protected flora species and protected fauna species. Two types of knowledge were also elicited: stated knowledge (do you know any PAS in Aragón?) and real knowledge (could you mention any PAS in Aragón?). Answers to this second item were cross-checked with the official PAS list provided by the Department of the Environment. Following this, the valuation framework was described. An initial piece of information was read to all interviewees to achieve a minimum level of knowledge. The exact wording of the text was:

Nature conservation in Aragón is carried out through the protection of species and areas. In Aragón out of a total of 4.000 flora species, 5.000 fauna species and 5 million hectares only 105 flora species, 77 fauna species and one and a half million hectares are protected because of its conservation state, potential threats or scarcity. One fourth of these species and areas can be considered as endemism, which means that if they disappear in Aragón, they will be totally extinct in the whole world.

After this basic information package came the valuation exercise. It was mentioned that conservation implied public expenditure and that if this were not undertaken it would lead to extinction of some species and degradation of some areas. Thus our value estimate is WTP for preventing species and areas disappearance[4]. The payment vehicle for WTP used is a voluntary contribution to a nature conservation fund. We discarded compulsory alternatives as payment vehicle (I.e. a tax or fee) due to the high number of protest bids associated with these options and the unfeasible connection between biodiversity and any existing tax or fee. The valuation process implemented included three steps: first individual are asked whether they would contribute to a fund such as the one described without mentioning any bid. People who declared that would be willing to contribute to this fund were then asked to declare the value of their maximum annual contribution for a 10-year period. A single bound dichotomous choice question with open-ended follow-up was used. The bid vector used for was composed of five values: 6, 18, 36, 60 and 120 € per year. The wording of the dichotomous choice question placed additional emphasis on the fact that answers should be related to real behaviour and that contributing to the proposed fund would reduce disposable income for other expenditure. Last, all individuals given WTP answers greater than cero we posed with and additional question. This third phase in the valuation process aims at introducing uncertainty in the analysis, and requests individuals to declare their degree of certainty with which the have provided the valuation answer using a one-to-ten scale. The questionnaire ended with the usual questions regarding socio-economic sample characteristics (age, gender, income, etc.) and attitudes and behaviour regarding the environment (recreational use of protected areas, paper and glass recycling habits, membership of environmental NGOs, etc.).

IV.- Results

The sample size used in the study comprised 1,001 inhabitants in the region of Aragon over 18-years of age and distributed according to the population size of the 33 counties existing in the region. Regarding the importance given by individual to the environment as a social issue, its worth mentioning that all social issues were valued as very important although significant differences using a Wilcoxon range test were detected. The data shows that the environment can be considered as a second level social issue, behind unemployment and education. Among the environmental issues mentioned in the survey, although they have been also valued in average as very important, we can detect significant differences with PAS also ranked in a second importance level group behind forest fires and water contamination[5].

---

[4] We assume that the "no protection" scenario would not lead to the disappearance of ALL species and areas as independently of protection efforts a minimum number of them would still survive. Thus we are valuing is avoiding the reduction in the number of areas and species derived from the lack of funding for conservation policies.

[5] It should be noted that these two environmental issues both contribute to the extinction and degradation of PAS.

Regarding declared PAS knowledge, Table 2 records the results for the three questions included in the questionnaire. As it can be seen declared knowledge is higher for protected areas than for species and among these, fauna are more known than flora one. This same pattern holds when we compare declared knowledge with the official data of PAS and real knowledge is considered. Real knowledge is computed considering three possible indicators: mentioning at least one species or area, mentioning at least one "correct" species or area and mentioning only "correct" species or areas. Although percentages decrease significantly, the hierarchy among these three components of natural heritage remains constant. It is worth noting that both the most mentioned species for flora and fauna were actually not protected.

Table 2. Knowledge of protected areas and species in Aragon (n = 1,001).

	% declares knowledge	Mentions at least one	Mentions at least one which is correct	All mentioned are correct
Protected areas	69.0	66.4	62.5	54.0
Protected fauna species	66.9	61,8	51.2	10.7
Protected flora species	37.3	32.0	15.3	6.5

Source: own calculations

Analysing the answers to the valuation questions, we now proceed to estimate mean WTP and value functions using the models presented in section II and compare the results with the theoretical framework. Table 3 reflects the raw data obtained for the different valuation questions. The first row presents the data to the question that classified individuals into "in the market" and "outside the market". The second row includes the analysis of those who while "in the market" accept or not the proposed bid in the dichotomous choice valuation question. This last sample is used both for three of the four models: two basic models Hanemann (1984) and Cameron and James (1987) and the extended model for uncertainty Li and Matsson (1995).

Table 3. Acceptance of hypothetical market and WTP.

	% Yes	% NO	% DN/DA
Are you willing to contribute? (N = 1,001)	40.7	55.7	3.6
Would you pay the bid? (N = 408)	54.7	38.7	6.6

Source: Own calculations

In order to estimate the Spike Model we have analysed negative answers to the initial valuation question. These individuals had to answer and additional question to identify their no-payment reasons, classifying those into "real ceros" and "protest bids". The former are individuals that are outside he market because all prices are above their WTP (which is cero) as they either lack financial resources o consider that the good being valued is not an attribute of their utility function. The latter reject the valuation function scenario be it for the payment vehicle, the property rights assignation or any other reason and we do not have no information regarding their real WTP. Out of 557 negative answers, 321 (57,6%) have been coded as "real ceros" and the remaining 236 (42,4%) as protest bids which have been excluded from our analysis. The sample used in the Spike model includes 702 individuals who accept the valuation scenario, 381 who are in the market (WTP>0) 321 who are not in the market (WTP=0).

Results for the simple Hanemann (1984) approach are presented in table 4. The mean WTP to preserve PAS in Aragon is around 60 € per year. Truncated mean, considering an upper threshold of the ninetieth percentile of declared WTP [6] (90€), increases this value to 70 or 74 € depending on the distribution assumptions. Additionally, we can estimate models including additional covariates (socio-economic, attitude and behaviour data) that can affect this probability of accepting the bid and consider the simple model proposed by Cameron and James (1987) mentioned in section II.

[6] Data obtained from the answers to the open endend follow-up valuation question.

Table 4. Logit and Probit models for single bounded dichotomous choice valuation questions without explanatory variables (Hanemann, 1984).

	Logitc Model			Probit Model		
Variables	Coefficient	T-Student	Prob.	Coefficient	T-Student	Prob.
Constant	1.87155	9.205801	0.000	1.144997	9.716371	0.000
Bid	-0.030856	-8.903326	0.000	-0.018455	-9.790996	0.000
Log. Likelihood	-202.8229			-202.6222		
LR Statistic	111.3887			111.7902		
LR Prob.	0.000000			0.000000		
McFadden's R^2	0.215438			0.216214		
% correct predictions	70.60			70.60		
Improvement % *	29.11			29.11		
N	381			381		
Mean WTP (€/year)	60.7			62.0		
Truncated Mean WTP (€/year)	69.6			74.2		
Median WTP (€/year)	60.7			62.0		

Source: Own calculations
*Improvement percentage with regards to a simple model with only a constant term.

Table 5 presents the same model including additional explanatory variables. The selection criteria, following the overall approach of expected behaviour according to economic theory, has been to include those variables with a better performance considering criteria such as t-Student statistic, % of correct predictions, likelihood statistic and MacFadden's R^2 as goodness to fit measures.

Table 5. Logit and Probit models for single bounded dichotomous choice valuation questions including explanatory variables (Hanemann, 1984).

	Logit			Probit		
Variables	Coefficient	T-Student	Prob.	Coefficient	T-Student	Prob.
CONSTANT	0.961813	2.153121	0.0313	0.572316	2.134054	0.0328
BID	-0.033598	-8.812744	0.0000	-0.019634	-9.682966	0.0000
REC_PAPER	0.668849	1.868150	0.0617	0.410496	1.925964	0.0541
LOW_INCOME	-0.702344	-2.545600	0.0109	-0.403673	-2.502438	0.0123
PA_KNOW	0.839961	2.724034	0.0064	0.482867	2.640120	0.0083
IMP_ENV	0.521160	1.829550	0.0673	0.293076	1.797294	0.0723
Log. Likelihood	-173.0433			-173.2505		
LR Statistic	138.3462			137.9318		
LR Prob.	0.000000			0.000000		
McFadden's R^2	0.285584			0.284728		
% correct predictions	79.83			79.83		
Improvement % *	51.35			51.35		
N	357			357		

Source: Own calculations
*Improvement percentage with regards to a simple model with only a constant term.

Variables included in the model have been constructed as follows. BID is a discrete variable with five levels (6, 18, 36, 60 and 120 €) reflecting the bid offered in the dichotomous choice valuation question. The negative sign implies that the probability of providing positive answers decreases as the bid offered increases (the demand curve has a negative slope). REC_PAPER is a dichotomous variable taking value one if the person declares that he recycles paper and cero otherwise. As expected those individuals showing a higher environmental conscience are more prone to accept the offered bid. LOW_INCOME is a dichotomous choice variable talking value one if the household income is below 1,200 € per month and cero otherwise. Both models show that the probability of accepting the posted bid is reduced for individuals with lower incomes.

PA_KNOW is a dichotomous choice variable taking value one if the person surveyed has mentioned at least one protected area that is really protected and cero otherwise. As indicated by the positive coefficient sign, individuals with correct knowledge of protected areas have a higher probability of accepting the proposed bid. Last IMP_ENV is a dummy variable taking value one if the individual has declared that all environmental problems mentioned in the survey are very important for him and that the environment as a social issue is also very important. The positive coefficient sign shows that, as expected, individuals with strong concern for environmental issues have a higher willingness to accept posted bids. All variables are significant at the 5% level except for IM_ENV and REC_PAPER which are significant at the 10% level. The overall model performance has been increased considerably with an average percentage of correct predictions close to 80% which implies a 51,3% improvement with regards to the naïve model.

Mean WTP has also been estimated using Cameron y James (1987) approach, assuming a log-linear functional for the valuation function, results are shown in Table 6 where explanatory variables are significant at the 5% level. We must also point out that one of the advantages of this approach is that estimated coefficients can be interpreted as percentage changes in WTP derived from a unitary change in the independent variable. Mean WTP is slightly higher than that obtained under Hanemann (1984) and is closer, as expected, to the truncated mean obtained in that model.

Table 6. WTP Simple model under the Cameron y James (1987) approach.

Variables	Coefficient	T-Statistic	Probability
CONSTANT	3.083909	10.59623	0.0000
REC_PAPER	0.472434	2.058701	0.0395
LOW_INCOME	-0.405528	-2.159260	0.0308
PA_KNOW	0.506185	2.311229	0.0208
IMP_ENV	0.379430	2.159326	0.0308
σ_{ε}	1.007429	9.342243	0.0000
Log. Likelihood	-160.1908		
Akaike Inf. Criterion	0.931041		
Schwarz Criterion	0.996213		
N	357		
MEAN WTP (€/year)	85.2		
MEDIAN WTP (€/year)	51.3		

Source: Own calculations

Introducing cero answers to the model following the criteria explained above, and assuming WTP is distributed as a logistic function as mentioned in section II, we estimate (9) using maximum likelihood and obtain the results presented in Table 7.

Table 7. Model comparison: Logit versus Spike.

	Logit			Spike		
Variable	Coefficient	T-statistic	Probability	Coefficient	T-statistic	Probability
CONSTANT	-0.030821	-0.24264	0.8083	0.063163	0.83205	0.4054
BID	-0.017825	-6.70073	0.0000	0.023896	14.9892	0.0000
Log. Likelihood	-410.9010			-693.5695		
Akaike Inf. Criterion	1.176356			1.981679		
Schwarz Criterion	1.189330			1.994654		
LR Statistic	55.83271			51.98432		
LR Probability	0.000000			0.000000		
N	702			702		
MEAN WTP (€/year)	-1.7€			30.3€		
MEDIAN WTP	-1.7€			2.6€		

Source: Own calculations

Considering a simple logit model as proposed by Hanemann (1984) results in negative mean WTP due to the high number of cero values considered. We then have to reconsider the model and apply the Spike model proposed by Kriström (1990) which assigns a positive probability to cero values. The probability of cero values is 0.52 (obtained as one minus 0.48 which is the value obtained applying (15)). Mean WTP for the Spike model is 30.3 €/year and median WTP 2.6 €/year, the big difference between this two values proof the fact that WTP distribution for nature conservation is asymmetric in our case. he results obtained support the choice of Spike models in a case as ours where a significant proportion of the sample has cero values for the good considered.

Considering the answers obtained to the certainty question (Table 8) we must highlight that nearly 5% of those accepting the bid and 11% of those not accepting it show a very low level of certainty. On the other hand there is a bigger group of individuals that are totally certain of their stated preferences, with a higher presence of certain positive answers than of negative ones. Nevertheless, the most abundant category is that of individuals with moderate certainty (between 50 and 100%) representing close to 60% of the total sample size.

Table 8. Answer distribution according to certainty level.

	Certainty level			
Valuation answer	<50%	(50% – 100%)	100%	Total
Yes	11	119	93	223
%	4,9%	53,4%	41,7%	100%
NO	18	106	34	158
%	11,4%	67,1%	21,5%	100%
ALL	29	225	127	381
%	7,6%	59,1%	33,3%	100%

Source: Own calculations

In order to introduce uncertainty into our model we assume a log-linear functional form for the valuation function. If we estimate directly through maximum likelihood (16) we still obtain a Mean WTP were the bias generated by uncertainty is still present. Uncertainty can be included using two options. First we can estimate a model as before but recoding answers in order to consider WTP y_i with values one only in those cases with full certainty (answers to the certainty question equal to 10 or 100%). Alternatively, we can use a two-step approach to include uncertain preferences. We use Li and Mattsson (1995) criteria to code stated preferences where a positive answer with 40% certainty is considered a negative answer with 60% certainty. Results obtained through maximum likelihood estimation of (15), (19) and (23) are presented in Table 9.

Table 9. WTP Models incorporating uncertainty.

	Simple model	Recoded model. (DC-10)[A]	Two-step model	
Variables	Coefficient T-statistic	Coefficient T-statistic	Coefficient T-statistic	
CONSTANT	3.0839 10.596*	0.7856 1.2001	3.083909 10.59623*	*3.421958* *35.64224**
REC_PAPER	0.4724 2.0587**	0.8807 1.8743***	0.472434 2.058701**	*0.230762* *2.656989**
LOW_IMCOME	-0.4055 -2.1593**	-0.6409 -2.0487**	-0.40553 -2.15926**	*-0.175805* *-2.848991**
PA_KNOW	0.5062 2.3112**	0.7436 1.9720**	0.506185 2.311229**	*0.216622* *3.227251**
IMP_ENV	0.3794 2.1593**	0.4941 1.6445	0.379430 2.159326**	*0.325559* *5.254596**
σ_ε	1.007429 9.3422*	1.6605 7.6052*		*0.622459*[D]

σ_e			1.007429 9.342243*	
σ_v				*0.792122* *32.90296**
Log. Likelihood	-160.1908	-156.5115	-160.1908	*-623.0164*
Akaike inf. Criteria	0.931041	0.910428	0.931041	*3.533800*
Schwarz Criteria	0.996213	0.975600	0.996213	*3.599108*
N	357	357	357	*357*
Mean WTP	85.17€	36.62€	77.62€[C]	*56.72€*[E]

*, ** and *** denote 1%, 5% and 10% significance levels respectively

A. Recoded model, assumes that only individuals with 100% certainty accept the posted bid,

B. Coefficients in italics are related to the second sep.

C. Estimated using second step coefficients as suggested by Li y Mattsson (1995), due to their higher consistency.,

D. Obtained as $\sigma_\varepsilon = \sqrt{\sigma_e^2 - \sigma_v^2}$, where σ_e^2 is the standard deviation of the composed error and σ_v^2 the standard deviation of the uncertainty term obtained in the second step..

E. Obtained considering σ_ε, which includes only the omitted variables error component.

Although the most relevant information of econometric and economic nature is presented in Table 9, we think the following aspects are worth highlighting. The first model delivers the highest mean WTP estimates as expected due to the bias generated by the presence of uncertainty in the random error term. The two options to minimize this bias have different implications. Recoding positive answers to exclude “maybe” expressions provides construct validity as all independent variables remain significant and with the expected sign. Mean WTP is consistent with results obtained by previous applications such as Loomis and Ekstrand (1998) or Berrens *et al.* (2002). This option provides the greatest reduction in mean WTP, in our case close to 60%, as conditions for certainty are very stringent when considering positive answers to the posted bid. The two-step approach exhibits the best statistic properties, with significant coefficients, in the second step, for all variables at the 1% confidence level and expected signs. These coefficients are used for WTP estimates using (18) due to their greater consistency. Mean WTP is obtained at 56.7€ once the uncertainty component in the variance has been eliminated.

V.- Summary and conclusion

This paper provides a tool to estimate welfare losses associated with reductions in quality and/or quantity of protected areas and species. The tool incorporates specific tests to account for two issues raised when considering non-use values estimation using stated preferences valuation methos: uncertainty in preferences for unfamiliar goods and cero values.

Table 10. Summary WTP Estimates under different models and assumptions (€/yr).

Basic models			Cero values taken into account	Uncertainty taken into account	
Hanemann (1984)		Cameron & James (1987)	Kriström (1990)	Recoded	Two-step
Logit	Probit				
69.6	74.2	85.2	30.3	36.6	56.7

Source: own calculations.

Table 10 summarises the results obtained in this study. Simple models such as those proposed by Hanemann (1984) and Cameron and James (1987) should be avoided when any of these two circumstances are present as they overestimate WTP significantly. In the case of exhibiting positive probability for cero valuation, the asymmetry in the valuation distribution implies that straightforward application of these models yields negative WTP estimates. Spike models account for this asymmetry and correct the estimates, this correction, in our case, is close to a 50% reduction of estimated WTP excluding cero values.

If we want to consider uncertainty we have to start from another basic model, that proposed by Cameron and James (1987). Estimates from this basic model are not significantly different from those of Hanemann (1984) but their approach allows for the inclusion of uncertainty corrections as the random term can be splitted into two components one due to omitted variables and one due to uncertainty in preferences. Recoding answers generates the greatest reduction in mean WTP although the effect of uncertainty is lower, in ant case, than the one generated by omission of cero values.

This results seems to provide support to NOAA Panel recommendations (Arrow *et al*. 1993) when mentioning that estimates for non-use values coming from dichotomous choice valuation questions should be halved to be taken into account in economic analysis. Although authors such as Harrison (2002) have pointed out that at the time of writing there was no scientific evidence regarding the validity of this, or, as a matter of fact, any of the recommendations, our results seem to justify this recommendation due to the lack of consideration of uncertainty or cero values.

The natural extension of our research is to consider both effects simultaneously, that is, a revisited spike model with the inclusion of uncertainty. This would allow both the consideration of a greater sample and the inclusion of non-cero probability for cero values as an advantage compared to our uncertainty model. This option is not as straightforward as it seems as we face problems both with the econometric specification and with the assignation of certainty levels to cero values. Additionally, subjective certainty (the one recorded in this study as stated certainty) could be compared to some objective measure (real WTP from auctions or experiments or preference temporal stability) as there is no performance benchmark for stated certainty data quality.

References

Arrow, K.; Solow, R.; Portney, P.; Leamer, E.; Radner, R.;, Schuman, H. (1993). Report of the NOAA Panel on contingent valuation. *Federal Register, 58(10)*, January 15, pp. 4602-4614.

Barreiro, J., Pérez y Pérez, L., del Saz, S. (1998). Valoración contingente y protección de espacios naturales. *Revista Valenciana d'Estudis Autonómics*, Vol. 23: 355-372.

Barreiro, J. (1999a). Beneficios y costes de los espacios naturales protegidos. V Jornadas sobre Desarrollo Sostenible de Urdaibai, Sukarrieta, 27-29 Octubre.

Barreiro, J. (1999b). *Valoración de los Beneficios Derivados de la Protección de Espacios Naturales: el caso del Parque Nacional de Ordesa y Monte Perdido*. Ministerio de Medio Ambiente, Publicaciones del Organismo Autónomo Parques Nacionales, Colección Técnica, Madrid.

Bateman, I., Willis, K.G., (1999). *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries*. Oxford, UK: Oxford University Press.

Bateman, I. Langford, I. (1997). Non-users' willingness to pay for a national park: an application and critique of the contingent valuation method. *Regional Studies*, 31(6): 571-582.

Berrens, R. P., Jenkins-Smith, H., Bohara, A. Silva C. (2002). Further investigation of voluntary contribution contingent valuation: fair share, time of contribution, and respondent uncertainty. *Journal of Environmental Economics and Management* 44: 144-168.

Bostedt, G., Boman, M. (1996). Non-response in contingent valuation--reducing uncertainty in value inference. *Environmental and Resource Economics* 8: 119-24.

Boyle, K. J., M. P. Welsh, M.P., Bishop, R.C. (1988). Validation of empirical measures of welfare change: comment. *Land Economics* 64: 94-98.

Brown, G. Shorgen , J. (1998). Economics of the Endangered Species Act. *Journal of Economic Perspectives*. 12(3): 3-20.

Cameron, T. A., James, M.D. (1987). Efficient estimation methods for "closed-ended" contingent valuation surveys. *The Review of Economics and Statistics* 69: 269-76.

Cameron, T. A. (1988). A new paradigm for valuing non-market goods using referendum data: maximum likelihood estimation by censored logistic regression. *Journal of Environmental Economics and Management* 15: 355-379.

Dubourg, W.R., Jones-Lee, M.W. Loomis, G. (1994). Imprecise preferences and the WTP-WTA disparity. *Journal of Risk and Uncertainty* 9: 115-133.

Dubourg, W.R., Jones-Lee, M.W. Loomes, G. (1997). Imprecise preferences and survey design in contingent valuation. *Economica* 64: 115-133.

EIN Aragón (2002). Inventario Socioeconómico y Dinamización Local para el PORN de la ZEPA de la Laguna de Gallocanta. Estudio Específico de Turismo. Informe para la Dirección General de Conservación de la Naturaleza, Departamento de Medio Ambiente, Gobierno de Aragón.

Elorrieta, I. Castellano, E. (1999). Valoración integral de la conservación de la biodiversidad de la Comunidad Foral de Navarra. Comunicación al 3er Congreso de Economía Navarra, Pamplona.

Hanemann, W. M. (1984). Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics* 66: 332-41.

Johansson, P.O., Kriström, B., K. G. Maler. B.K. (1989). Welfare evaluations in contingent valuation experiments with discrete response data: comment. *American Journal of Agricultural Economics* 71: 1054-56.

Kriström, B. (1990). Valuing Environmental Benefits Using the Contingent Valuation Method. Umea Economic Studies. University of Umea.

Kriström, B. (1997). Spike models in contingent valuation. *American Journal of Agricultural Economics* 79: 1013-23.

Li, C. Z., Mattsson, L. (1995). Discrete choice under preference uncertainty: an improved structural model for contingent valuation. *Journal of Environmental Economics and Management* 28: 256-69.

Loomis, J., Ekstrand, E. (1998). Alternative approaches for incorporating respondent uncertainty when estimating willingness to pay: the case of the Mexican Spotted Owl. *Ecological Economics* 27: 29-41.

Mcfadden, D., Leonard, G.K. (1993). Issues in the contingent valuation of environmental goods: methodologies for data collection and analysis. In Haussman (Ed.) *Contingent Valuation a Critical Assessment*. Amsterdam: North –Holland, 165-216.

Mitchel, R.; Carson, R. (1989). *Using Surveys to Value Public Goods*. Washington DC: Resource for the Future.

Patterson, D. A., Duffield J.W. (1991). Comment on Cameron's censored logistic regression model for referendum data. *Journal of Environmental Economics and Management* 20: 275-83.

Pérez y Pérez, L., Barreiro, J., Barberán, R., Del Saz (1998). *El Parque Posets-Maladeta. (Aproximación Económica a su Valor de Uso Recreativo).* Zaragoza: Publicaciones del Consejo de protección de la Naturaleza de Aragón, Serie Investigación, Número 8.

Rebolledo, D.; Pérez y Pérez (1994). Valoración Contingente de Bienes Ambientales. Aplicación al Parque Natural de la Dehesa del Moncayo. Documento de Trabajo 94/6, Unidad de Economía Agraria, Servicio de Investigación Agraria, Diputación General de Aragón.

Smith, V.K.; Osborne, L. (1996). Do contingent valuation estimates pass a scope test? A meta-analysis. *Journal of Environmental Economics and Management* 31: 287-301.

Van Kooten, G. C., Krcmar, E., Bulte, E.H. (2001). Preference Uncertainty in Non-Market Valuation: A Fuzzy Approach. *American Journal of Agricultural Economics* 83: 487-500.