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Manuel González Gómez, Philippe Polomé y Albino Prada Blanco
Departamento de Economía Aplicada
Universidade de Vigo
Lagoas-Marcosende s/n. 36200 Vigo.
Mgzlez@uvigo.es

FUNCIONAL FORMS, SAMPLING CONSIDERATIONS AND ESTIMATION OF DEMAND FOR PROTECTED NATURAL AREAS: THE CÍES ISLANDS CASE STUDY IN GALICIA (SPAIN).

ENTIDADES COLABORADORES

Fundación Caixa Galicia
Consello Económico e Social de Galicia
Fundación Feiraco
Instituto de Estudios Económicos de Galicia Pedro Barrié de la Maza

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Abstract

In this paper, we present estimates of several models of demand for a natural area using data from surveys on visitors and non-visitors. The estimates take into account the problems of: demand specification, measurement of the cost and of the demand, choosing sampling scheme, and handling the sample. Considering these alternatives allows us to select a model of demand under improved conditions and frees us from initial restrictive hypothesis. The results in terms of prediction of demand and consumer surplus estimates are quite dissimilar, stressing the importance of comparing various models that encompass the range of possible options

Keywords: Travel Cost Method, Endogeneous Stratification, Truncation, Demand specification, Hurdle models.

Resumen

En este trabajo presentamos estimaciones de diferentes modelos de demanda para un espacio recreativo a partir de la información de entrevistas a visitantes y no visitantes. La estimación tiene en cuenta los problemas de especificación de demanda, de medición del coste y demanda, de elección de una técnica de muestreo y de tratamiento de la muestra. La consideración de estas alternativas permite elegir una modelización en mejores condiciones y nos aleja de supuestos iniciales restrictivos. Los resultados en términos de predicción de la demanda y estimación del excedente son bastante divergentes, resaltando la importancia de comparar diferentes modelos que incluyan el espectro de opciones potenciales.

Palabras Clave: método de los costes de viaje, estratificación endógena, truncación, especificación de demanda, modelos valla.

1. Introduction

Quantification of the value of the environmental services generated by nature areas, on the basis of a measurement of public preferences, enables us to determine the benefits generated and thus to carry out an efficiency analysis. Once this efficiency value is known, projects can be evaluated *ex–ante* and the results of intervention, *ex-post*; a cost-effectiveness analysis permits the least-cost invention to be selected, and a cost-benefit analysis permits the social return for a project or intervention to be calculated. The methods utilised for such quantification are contingency valuation, hedonic pricing and travel costs.

There are numerous applications of the travel cost and contingency valuation methods particularly. The travel cost method utilises costs and observed behaviour in order to estimate the demand function and calculate a measurement of welfare. The number of visits is considered to be a measure of the demand for an area of nature, whereas the sum of both the travelling and opportunity costs is taken as a 'proxy' of the price variable. In recent decades alternatives have been proposed for specific aspects of the estimation process, namely, functional forms, dependent variables, endogenous stratification and *in situ* sampling, or the costs to be considered relevant.

It is common practice in applications to initially opt for a concrete specification and to then proceed to the calculation of the measure of welfare (Riera et al., 1994; Garrido et al., 1996; González, 1997, Pérez y Barreiro, 1998, Farré, 1998; Del Saz y Pérez, 1999 for Spain). There are also studies that compare the effect of different specifications; Hanley (1989) obtains results with a squared functional form and with cost and demand logarithms; Willis and Garrod (1991) estimate a demand function with truncation utilising several functional forms; Hellerstein (1991) utilises a semi-logarithmic functional form and two discrete distributions – the Poisson and negative binomial distributions; Dobbs (1993) employs discrete and continuous models and also analyses the effect of different sample size; Englin and Lambert (1995) compare results using two discrete distributions – again the Poisson and negative binomial distributions; and finally, Englin and Shonkwiler (1995) compare the consequences of different handling of a sample taken in the area of the visit (*in situ* sampling).

In this paper, we systemise and amplify these comparisons. Five kinds of problems that are encountered when estimating demand for an area of nature are considered with a view to calculating a measure of welfare. The first of these problems is the choice of sampling method. In order to collect information, a sample is frequently obtained in the area itself, but it is also possible to utilise a simple random sample taken within the catchment area of the nature park in question. The advantages of both of these methods will be compared below. The second problem refers to the handling of samples taken in the visited area. These are not simple random samples, for which reason the conventional estimation techniques are not valid. We will, therefore, discuss three ways of modelling these samples. The third problem we tackle is the very definition of demand for an area of nature. Usually this is measured on the basis of the number of visits during a specific period of time. However, intuitively it can be affirmed that the stay in the nature area also forms part of the demand. We will therefore contrast results utilising conventional measures, and also a measure that will incorporate the period of stay in the nature area. The fourth problem deals with a specification of the demand. Either a discrete distribution – where demand is expressed in levels - or a continuous distribution - where demand can be expressed in levels or logarithms - can be employed. Hence, two discrete distributions (Poisson and negative binomial) and one continuous distribution (normal) will be compared. Finally, the fifth problem is measurement of price on the basis of displacement cost. Seven definitions of cost are considered, depending on which expenses are considered appropriate for inclusion in the displacement cost. To sum up, this procedure incorporating a wide range of options is naturally complex in calculation terms, but it does permit a determination of the welfare measure on the basis of more complete information and without having to jettison options from the outset.

To complement estimations of the benefits generated by an area of nature, it is common practice to study the demand for an area by considering that substitutes exist (discrete choice models or random utility models). Such a focus permits an analysis of changes to welfare resulting from modifications to the nature areas in terms of quality or quantity. In our particular case, the Cíes Islands (off the coast of Vigo, Spain) represent the only island enclave in an estuary of the Iberian Peninsula that is designated a natural park. In addition the islands can count on infrastructures for recreational use and on conservation measures (absence of motor vehicles, urbanisation and waste, and special reclamation and conservation programmes for flora and fauna). These factors permit the affirmation that near substitutes do not in fact exist. A multitude of secondary options distributed throughout the entire peninsula do exist, but to include them all in a demand system and to collect the necessary data would be an interminable and enormously difficult process.

Our next section (Section 2) will describe the problems of demand specification (functional forms), sample handling, and demand measurement. In Section 3 we will tackle the application to the Cíes Islands of the *in situ* sampling technique and describe the different measurements of displacement cost. In Section 4 we will describe the application to the Cíes Islands of a case of simple random sampling of visitors and non-visitors representative of the province of Pontevedra (the immediate catchment area for the Islands). Finally, Section 5 will describe our conclusions.

2. Functional forms, sample handling and demand measurement

2. a. Functional forms

Some authors estimate demand for a recreation area by taking the endogenous variable as continuous and assuming it is an option for dealing with the number of journeys that individuals make (Willis and Garrod, 1991; Smith and Desvouges, 1988; and Dobbs, 1993, among others). Another option, predominant in recent applications, explicitly takes into account the discrete nature of the dependent variable. In this case the negative binomial (usually in the form BN2, see Cameron and Trivedi, 1998) and Poisson (Hellerstein and Mendelsohn, 1993) probability functions are those most utilised. The BN2 is essentially a Poisson model in which the non-observed heterogeneity between different individuals is modelled by means of a gamma distributed noise. In this way one of the Poisson model restrictions is avoided, namely, the property of equi-dispersion - which is to say, the mean of the distribution should be equal to its variance. Very often this property is not verified in practice, and the BN2 distribution is therefore more appropriate than the Poisson. In theory it would be possible also to employ other distributions, but the Poisson and the BN2 are the only distributions for which the necessary results have been developed for all the ways of handling samples that are under consideration here. It must be emphasised that if cost expressed in logarithms is taken for the two discrete models, an infinite consumer surplus would almost invariably be imposed (Appendix I). For this reason, only cost expressed in levels for the discrete models has been taken into consideration.

Four possibilities exist for modelling the endogenous variable as continuous. These are: the LinLin model, in which - assuming a normal distribution - both the endogenous variable and the cost are expressed in levels; the LinLog model, with the endogenous variable distributed normally in levels and with cost expressed in logarithms; the LogLin model, with the logarithm of the endogenenous variable distributed normally and with cost expressed in levels; and finally the LogLog model, with the logarithm of the endogenous variable distributed normally and with cost expressed in logarithms. For the LogLin and LogLog models, it is not possible to predict null values for the endogenous variable (the zero logarithm is not defined), and hence, the consumer surplus will always be infinite. To avoid this problem, 1 is added to the endogenous variable before making the estimation. Distributions other than the normal distribution could also be considered but results do not exist for all the sample treatments under consideration.

To sum up then, there are six basic models, one for each definition of the endogenous variable. These are summarised in Table 1, where *Y* is the endogenous variable, *p* is the displacement cost with coefficient β, α is a constant that represents the linear combination of all the other regressors multiplied by their respective coefficients, *E* is the expectation operator, and finally *y exp* is the exponential operator.

Table 1: Basic models

Poisson, BN2:	$EY = \exp(\alpha + \beta p)$		
LinLin:	$Y = \alpha + \beta p + u$	$u \sim n(0,\sigma^2)$	$EY = \alpha + \beta p$
LinLog	$Y = \alpha + \beta \ln(p) + u$	$u \sim n(0, \sigma^2)$	$EY = \alpha + \beta \ln(p)$
LogLin	$\ln(Y+1) = \alpha + \beta p + u$	$u \sim n(0, \sigma^2)$	$EY = \exp(\alpha + \beta p + \sigma^2/2) - 1$
LogLog	$\ln(Y+1) = \alpha + \beta \ln(p) + u$	$u \sim n(0, \sigma^2)$	$EY = p^{\beta} \exp(\alpha + \sigma^2/2) - 1$

2. b. Sample handling

There are basically two ways of obtaining a sample via observations of quantities of recreational demand. The first, and probably the most common way, is to sample within the recreational area. The second obtains a simple random sample from a reference population. The majority of applications make use of the former (Pérez y Barreiro, 1998, Farré, 1998; González, 1997, Garrido, 1996, Riera et al., 1994; Campos et al, 1996). The principal reason for obtaining an *in situ* sample is that of compiling information on costs, especially in cases where the visitors may be from very diverse origins. Nevertheless, this is not simple random sampling, and therefore the conventional techniques for calculation of demand should be modified (Shaw, 1988). In particular, given that there is no null demand with this kind of sampling, the observed demand is truncated at zero. In this paper we compare the properties of the two sampling methods in respect of their capacity for obtaining a reliable estimate of the consumer surplus. Section 3 presents the results obtained on the basis of a sample taken *in situ* and Section 4 complements this sample with a non-visitor sample in order to obtain new results.

For the sample taken *in situ*, we apply three handling methods: the non-truncated method, in which there is no modification to the distribution of the endogenous variable, except for the continuous models where distribution at zero is censored[1] (demand can never be negative); the truncated method in which the distribution of the endogenous variable is truncated[2] at one (a sample of visitors does not include values that are lower than one); and finally, the *in situ* treatment, in which the distribution of the endogenous variable is modified in accordance with this kind of sample in the way described above (see Shaw, 1988, for the continuous and Poisson models; Englin and Shonkwiler, 1995, for the BN2 model). All the models are estimated for maximum verisimilitude. Depending on the handling of the sample, the expectation for the endogenous variable is modified (Table 1). (See Greene, 1999, for the censored and truncated continuous models; Cameron and Trivedi, 1998, for the truncated and *in situ* discrete models; and Shaw, 1988, for the *in situ* continuous models).

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[1] See Greene (1998) for a theoretical description of these models.
[2] See Greene (1998) for the continuous models and Cameron & Trivedi (1998) for the discrete models.

The truncated samples

A sample such as that of visitors to the Cíes Islands is truncated because no null demand is observed. It seems therefore a good idea to build into the estimation process the information that if no zero is found, it is not because the function to be estimated cannot predict null values, but rather due to the configuration of the sample.

Demand theory defines consumer surplus as the area below the demand curve, from the price that this consumer pays to the cut-off price (possibly infinite). Hence, in order to calculate the consumer surplus it is necessary to predict the behaviour of demand as it approaches zero. With a truncated sample this information is to be found outside the sample space. It is thus a matter of defining demand over the entire range of price (or cost, or any other variable) on the basis of the information obtained from the truncated sample.

Let Yi be the displacement demand for visitor i. Based on a demand distribution (e.g. Poisson), we can define the truncated distribution, the parameters of which are estimated from the sample. The conditional expected demand to visit $E(Yi \mid Yi \geq 1)$ can be calculated on the basis of this estimation. By construction, this conditional demand can never be null, and hence, if we try to calculate a consumer surplus on the basis of this conditional demand, it will of necessity be infinite. Nonetheless, it is a well-known fact that as the displacement cost increases, the probability of a visit decreases. Therefore, the unconditional expected demand for a visitor is the product of the conditional expected demand multiplied by the probability of the visit, i.e.:

$$E(Yi) = E(Yi \mid Yi \geq 1) \Pr\{Yi \geq 1\}.$$

Now this product happens to be the expectation for the original Poisson distribution. Hence, we estimate the conditional expectation from the sample utilising a truncated distribution, and to calculate the consumer surplus we substitute the estimated coefficients into the initial Poisson distribution.

The *in situ* samples

The *in situ* samples are obtained when visitors are interviewed randomly (whether in a nature zone or in a supermarket) in the very place of the visit. By construction, these samples are truncated given that non-visitors obviously cannot be interviewed *in situ*. In addition, however, those who visit frequently have a greater chance of being interviewed, and will therefore be over-represented in the resulting sample, and inversely for those who visit the area least (Shaw, 1988). Thus, if we calculate the average number of visits on the basis of such a sample, we will overestimate the real average of visits. Shaw (1988) demonstrated how a Poisson or normal distribution, in this case, would have to be modified. Englin and Shonkwiler (1995) extended these results to the case of a BN2 distribution. For the discrete models, the correction consists of applying weights to the probabilities for each number of visits in order to reflect the fact that the probability of being interviewed increases with the number of visits. A reasoning process similar to that for the truncated samples can be applied to the *in situ* samples in order to demonstrate that the unconditional expected demand on which we calculate the surplus is the expectation of the original distribution.

2. c. Measurement of demand

The estimation of demand for an area of nature tends to use the number of visits to the area as a measure of demand, based on the assumption that the duration of these visits is constant. There are several arguments in favour of this approach; it is a variable that is perfectly valid for a description of individual behaviour; in some cases the nature zone does not permit stays of more than a day; there is little or no information about average stay, and/or the study only includes visits of one day or less.

Nevertheless, we could argue that the visitor in fact does not only decide the number of visits, but at the same time, the duration of the visits (or stay). It is generally acknowledged that length of stay in an area may play an important role in explaining demand for an area of nature - to be able to stay for several days means that the visitor can allocate his travelling costs to a greater number of days. Bell and Leeworthy (1990) constructed stay in days as a function of the cost incurred by each one, unlike the traditional versions where travelling costs are related to the number of displacements made. Finally the possibility of staying more than one day in the area of nature might well be considered an attraction rather than a cost.

In this paper, we utilise two measures of demand for an area of nature. The first measure is based on the traditional notion of the number of visits, which we consider here in the long term (the 5 years prior to the survey). We call this variable 'displacement'. The second measure considers that the two variables (number of visits and stay) are both aspects of the same demand - that of days in the park – as applied previously by Bell and Leeworthy (1990). It would be possible to construct a system of two simultaneous equations - one for number of visits and another for stay - but it is considered here that both these variables can be represented in terms of the average demand in terms of days' stay on the Islands. In order to construct this variable the individual number of visits was multiplied by the declared number of days[3] stayed by the respondent, this number being considered a good indicator of the average individual stay. We will call this variable 'total stay'.

Thus we can make the estimate of demand on the basis of the number of visits *or* as the number of visits multiplied by length of stay. These can be then be considered as either continuous or discrete. For the continuous version, the 4 forms described in Table 1 can be used (LinLin, LinLog, LogLin, or LogLog) under an assumption of normality; in the discrete version the two usual distributions (Poisson and BN2) can be employed. For each of these specifications, three sample treatments can be applied (non-truncated, truncated and *in situ*). We thus have a total of 36 different models.

3. Visitor sampling

The samples utilised were personal interviews with visitors to the Cíes Islands during the summer of 1998. A complete description of these interviews can be found in González *et al* (2000). Below we describe both the regressors that were employed in order to estimate the models described in the previous section and the results of the estimations.

Explanatory variables and definition of displacement cost

The sensitivity of the consumer surplus to the determination of the displacement cost makes it necessary to refine the values utilised for this variable. The cost is

[3] Part of a day is considered a day's stay.

known only to the visitor and is not verifiable by others. According to Randall (1994), the determination of the individual displacement cost on the part of the researcher is largely arbitrary. The researcher will, therefore, only have recourse to existing practices, and any measure or estimation of welfare will depend on the chosen method.

For this application the cost variable is defined as the sum of the costs that the visitors declare to have incurred. The costs are weighted in different ways in order to arrive at seven definitions of the displacement cost, and the estimation process will determine the cost that best explains the demand for each model. For the opportunity cost of time we will consider the wage given in the working population survey[4] less the average deduction made by the tax authorities (1063 pesetas). The seven formal definitions of cost are fully described in Appendix 2; in summarised form, these are:

- *Ca*, total cost, a summary of all costs including nights of arrival and departure
- *Cn*, which does not take into account nights spent away from the Islands
- *Cc*, displacement from home to ferry port is only a cost for those who declare it so
- *Cd*, length of stay in the Islands is irrelevant (they can be visited in a single day)
- *Ct*, the opportunity cost of time is null (Spanish labour market inflexibility)
- *Cm,* the cost of getting to the temporary residence is only counted for those visitors whose principal motive for travelling is the visit to the Islands
- *Tim* and *C*, the monetary and time costs are considered separately.

In addition to cost, variables included as possible explanatory variables are listed as follows: the equivalent adult income according to the OECD (*income*), enquired about in terms of income bands; a green index (*green*), defined by the sum of 6 dichotomous variables indicating various kinds of environmentally-sensitive behaviour; a knowledge index for the Islands (*know*), defined by the sum of 6 dichotomous variables indicating whether the respondent has visited specific areas of the Islands; a

[4] *Encuesta de Población Activa*, a census carried out regularly by the Spanish National Employment Institute.

response reliability index (*rel*), consisting of the sum of three dichotomous variables that cover various aspects of the degree of confidence that the interviewer feels for the answers of the respondent; the age of the respondent (*/age*) normalised to the maximum band value, the sex of the respondent (*sex*), two dichotomous variables (*djuly* and *dsept)* that indicate the month when the interview took place; other variables indicating whether the respondent had a remunerated employment (*remu*), whether there were children in the home (*child*), whether education was to secondary or tertiary level (*educ*), whether the respondent was satisfied with the visit (*satis*), and finally, whether information on the Islands had been available to the respondent before the visit (*info*).

Dichotomous variables were also included that indicated which of a list of features of the Islands the respondent considered to be the principal attractions, namely, trekking (*trkk*), nature observation (*nature*), absence of pollution (*conta*), beaches (b*each*) and tranquillity (*tranq*).

For each cost concept, the estimation of each one of the 36 models is based on the set of 19 potential regressors described above, subsequently reduced by the elimination of variables. Firstly, chosen for each model is the cost for which the greatest likelihood is obtained; to be called dominant cost, this is described in Table 2. Next the elimination process utilises t-contrasts in order to identify the regressors that may not be significant. Finally, likelihood ratio test utilised in order to check that the initial set can be reduced by more than one non-significant regressor. All the contrasts are made at 5%. The final set of significant regressors for each model is described in Table 2.

The proposed models are non-linear and on more than one occasion it happens that the process of estimation does not converge with the initial set of regressors but rather with a reduced set. Evidently the choice of this reduced set is arbitrary and the estimations are hence less reliable. In order to make a selection for this reduced set that minimises arbitrariness as much as possible, all the models that converged were first estimated with the initial set of regressors. The reduced set was then defined by the union of the final regressors (of the models that converged) with the initial set. In Tables 2 and 4 the models that did not originally converge appear in the squares in grey. Finally, some models do not converge with any set of regressors, probably indicating that they do not describe the data sufficiently well.

Table 2. Dominant cost and significant regressors

	Displacement			Total stay		
Model	Non truncated	Truncated	In situ	Non truncated	Truncated	In situ
Poisson	ca beach tranq know educ age	ca beach tranq know educ age sex	ca beach tranq know educ age	*Dominate by the non truncated NB2*	*Dominate by the truncated NB2*	*Dominate by the In situ NB2*
BN2	*Colapses to a non truncated Poisson*	*Colapses to a truncated Poisson*	*Colapses to a Poisson In situ*	ca beach know educ age green info	ca (*) beach tranq know	ca (*) beach tranq know
LinLin	ca beach know educ	*Non convergence*	*Non convergence*	ca know info	*Non convergence*	*Non convergence*
LinLog	cc beach tranq know educ info	cc beach know educ	*Non convergence*	cn dsept know	*Non convergence*	*Non convergence*
LogLin	ca beach know educ age	ca beach know educ age	ca beach know educ age	ca beach know child info	ca beach know child	ca beach know
LogLog	ct beach tranq know educ age info	ct beach tranq know educ age info	*Non convergence*	ca beach know child info	ca beach know child	Ca (*) beach know

(*)These models only converge if the conditions for convergence are relaxed somewhat, and for the discrete models, if observations in respect of stays of more than 20 days are eliminated.

Of note is the fact that the dominant cost is ca, representing the sum of all the expenses incurred by the visitor. It would therefore seem appropriate to avoid eliminating any kind of expense from the cost definition. Of note also is the fact that income is at no time significant, which would indicate that the recreational cost is separable from the other costs in the individual utility function. Finally, the sets of significant regressors are quite similar between models, which would indicate that neither the specification nor the handling of the sample is crucial for an understanding of which factors are determinants of demand.

Results in prediction terms

It is generally difficult to compare these models, since there is no contrast that would compare them all. One way to compare the results of the different models is on the basis of their predictions within the sample. Two measures can be used - the hit rate and the sum of the squared residuals. For an observation x_i we define a hit if the above-mentioned value is to be located in the interval *(x_i – 0,5; x_i + 0,5),* in which case it would take the value 1 (and 0 if outside the interval). The residual is defined simply as the difference between the model prediction and the observation. The sum of squared residuals is therefore a measure of the distance between the prediction and the observation. Both rules are arbitrary, but they should bring together the best part of the goodness of fit of the model. Table 4 describes the results for the hit rate and the sum of squared residuals.

Calculated surpluses

The calculation of the surplus will depend on the model employed and is, in general, the integral of expected demand (Table 1) from the current cost (sample mean, for example) to the cut-off cost. In the Poisson and BN2 discrete models, the cut-off cost is by construction infinite, since at any cost there is a probability, however small, of a positive demand. Table 3 describes the consumer surpluses for the six basic models described in Table 1. With the exception of the two discrete models, these formula change in accordance with the handling of the sample, given that expected demand changes (see above). The notation is the same as in Table 1.

Cuadro 3. Choke price and consumer surplus for basic models

Poisson, BN2:	Choke price	infinite
	Consumer surplus	$-\exp(\alpha + \beta p) / \beta$
LinLin:	Choke price	$cp = -\alpha / \beta$
	Consumer surplus	$-\alpha^2 + \alpha^2 / 2\beta - \alpha p - \beta p^2 / 2$
LinLog:	Choke price	$cp = \exp(-\alpha / \beta)$
	Consumer surplus	$-\beta \exp(-\alpha / \beta) - \alpha p - \beta (p \ln p - p)$
LogLin:	Choke price	$cp = -(\alpha + \sigma^2/2) / \beta$
	Consumer surplus	$(1-\exp(\alpha + \beta p + \sigma^2 / 2)) / \beta$
LogLog:	Choke price	$cp = \exp(-(\alpha + \sigma^2 / 2) / \beta)$
	Consumer surplus	
$\exp(\alpha + \sigma^2 / 2) (\exp[-(\alpha + \sigma^2 / 2) (\beta + 1) / \beta] - p^{\beta+1}) / (\beta + 1) - \exp[-(\alpha + \sigma^2 / 2) / \beta] + p$		

Table 4 describes the surplus and cut-off cost estimations for each of the models, calculated for the sample mean of the regressors.

Table 4. Hit rate; sum of the squared residuals; expected consumer surplus; expected cut-off cost.[5]

	Displacement			Total stay		
Model	Non truncated	Truncated	In situ	Non truncated	Truncated	In situ
Poisson	59,4 % 758 41 350 ∞	72,5 % 671 1 695 ∞	71,2 % 671 750 ∞	*Dominate by the non truncated BN2*	*Dominate by the truncated BN2*	*Dominate by the In situ BN2*
BN2	*Colapses to a non truncated Poisson*	*Colapses to a truncated Poisson*	*Colapses to a In situ Poisson*	33,8 % 224 353 28 212 ∞	60 % 242 983 0 ∞	60 % 241 772 0 ∞
LinLin	44,2 % 1 158 < 0 49 238	*Non convergence*	*Non convergence*	0,4 % 283 489 < 0 25 647	*Non convergence*	*Non convergence*
LinLog	46,5 % 1 172 47 385 105 540	56,5 % 1 215 1 133 2 165	*Non convergence*	0,4 % 287 015 10 943 3 316	*Non convergence*	*Non convergence*
LogLin	81,9 % 1 288 122 059 87 286	81,9 % 1 289 109 947 79 965	80,4 % 1 264 (†) (†)	67,1 % 258 538 89 189 59 608	65,8 % 258 658 39 905 34 800	15,8 % 259 052 (†) (†)
LogLog	81,2 % 1 282 407 827 325 337	81,3 % 1 282 325 337 1 973 947	*Non convergence*	62,1 % 258 520 46 832 118 401	64,2 % 258 572 16 722 49 545	28,8 % 256 721 (†) (†)

(†) The consumer surplus and choke price are difficult to calculate, but in accordance with the hit rate and squared residual sum criteria, these models are eliminated.

The results in Table 4 are very dispersed, which would indicate little robustness in the face of different specifications or handling of the sample. In accordance with the criterion of the hit rate, we select the LogLin or LogLog models to explain the displacements. Nevertheless, the good results are associated with pecularities of the sample; most of the predictions for these models are to be found around one - even in cases in which the observed demand is much greater - whereas the observed frequency of visits equal to one is 80%. In other words, with this sample a blind prediction of one visit for any one observation would have a success rate of 80%. These models perform less well than the discrete models when the criterion is the sum of the squared residuals. In this case, the best models correspond to a truncated or even an *in situ* handling for the displacements, and a non-truncated handling for the entire stay.

[5] The truncated BN2 and *in situ* models for total stay had to be estimated after eliminating observations of greater than 20 days. Hence their hit rates and squared residual sums are not strictly comparable with other models. In order to make these more comparable, included in the prediction were the observations that had been eliminated for the estimation.

The total stay seems to be more difficult to explain than the displacements, indicating perhaps, that the two aspects of demand (displacements and stay) should be modelled separately and not together as modelled here. The table of the significant regressors is convincing in this sense, given that overall, fewer regressors are needed to explain the total stay than are needed to explain the number of displacements, which would indicate the presence of additional noise. The convergence difficulties of the discrete models with this endogenous variable is probably due to the fact that some observations are very atypical (very much above the mean). These observations should perhaps be excluded, but to do this would increase the arbitrariness of the results. For these reasons it seems preferable to model the recreational demand of an area of nature in terms of displacements and without taking into account the stay.

Notable differences occur in the surplus estimation, depending on the handling of the sample, the measurement of demand or the specification. It is fundamental therefore to compare the results from various models before selecting a measure for the consumer surplus.

From all the above observations it appears that the most reliable results are to be obtained by discrete displacement models, where the handling of the sample is critical for the calculation of the consumer surplus. In accordance with the criterion of the sum of the squared residuals, we allow that truncation should be taken into account, but it is not clear whether to use a simple truncated model or an *in situ* model; the difference in the surpluses is considerable. The decision between the two is made on the basis of statistical rigour, which requires the structure of the sample to be reproduced as faithfully as possible. On this basis, a Poisson *in situ* model is chosen.

4. Representative sample from a reference population

The alternative to sampling *in situ* is a simple random sample from a specific population. The fundamental interest in recurring to such a sample is that non-visitors provide information regarding zero demand behaviour, in other words, information regarding the way in which visitor demand would be cancelled if the displacement cost were to be increased. This idea depends crucially on the hypothesis that non-visitors essentially manifest the same behaviour patterns as visitors, and the principal reason that they do not visit is because the displacement cost is too high. However, another possible reason for not visiting could be that non-visitors have a preference structure that is different from that of visitors; in other words, even given a lower displacement cost, they would still not be interested in a visit.

If this is the case, then it is evident that non-visitors prove nothing about visitor behaviour as the cost of displacement increases, and therefore would not be of any value in calculating the consumer surplus.

In theory, since the visitors may come from anywhere, the area of reference for a representative sample set is potentially very large. For our particular case, this meant excluding all the observations for visitors from outside the area of reference. It was decided to restrict the sample to the province of Pontevedra, it being the area from which the majority of visitors come. The representative sample was constructed by complementing the observations that had been previously obtained for visitors with observations for non-visitors resident in this province. Preliminary telephone interviews were carried out in order to establish the visitor/non-visitor proportions for the province. Next, from the number of visitors from Pontevedra, distributed in 3 zones in function of the level of visits, the number of interviews to non-visitors necessary for a representative sample of this province was calculated.[6]

A sample set from Pontevedra province consisting of 180 observations was thus made available. This sample is qualitatively different from that of the visitors in that it is intended to be representative of Pontevedra. A Kolmogoroff-Smirnoff test was applied to check that there was no difference between the sample and population proportions for the age and sex variables. Likewise, the sample was layered in accordance with the size of the municipality of residence (five sizes), with no significant difference between this and the population.

We now approach the empirical verification of the hypothesis that visitors and non-visitors have the same preference structure. The method is quite a classic in certain economic disciplines such as health economics (Cameron and Trivedi, 1998), but is less frequently applied in environmental economics. Using the sample set of visitors and non-visitors, two models of demand are compared. The first is a classical

[6] For the technical details of the construction of this combined sample, see González *et al.* 2000.

survey model (for example, Poisson) for which the same preference structure is assumed, and the non-visitors are simply zero demand governed by the same regressors as visitor demand. The second is the hurdle model. In order to compare it with the survey model, the same endogenous structure is imposed, but the model is divided into two parts. The first part is a discrete choice model in which the probability that a person in the sample is a visitor; in the second part a truncated model is calculated, explaining the number of visits to the park as conditional on having visited it, as in the previous section. The comparison consists of assessing the two models in terms of which explains the data better (greater verisimilitude); if it is the first, then the same factors explains both the zeros and the positive demand numbers; and if it is the second, then the decision to visit is qualitatively different from that of the number of journeys. In this latter case, non-visitors are not simply potential visitors who consider the displacement cost to be excessively high, and therefore, the calculation of the consumer surplus should be made only on the basis of the truncated model.

Given the results obtained for the visitors in the previous section, only discrete models are used, namely, Poisson and BN2. The set of the potential regressors is different from that for visitors since some of the variables are not defined for non-visitors. The most important of these is the subjective cost of a journey to the islands, which was substituted with the distance (*km*) from the home to the ferry port. The variable *conoc/know,* referring to knowledge of the Islands, is defined for non-visitors, with the difference that these have not directly experienced those aspects but only know of their existence. The *info* variable - indicating whether the visitor had access to information on the Islands prior to the visit - is converted for non-visitors to whether they had ever received any information. The set of potential regressors remaining the same for the two samples are *sex*, *rel*, *remu*, *educ*, *green*, *child*, *trkk*, *nature*, *conta*, *beach*, *tranq* and *income*. All non-dichotomous variables are normalised via division by their respective maxima in the sample set, in order to speed up the estimation process.

Unfortunately, none of the two specifications converge with the set of all the possible explanatory variables. Elimination, however, of the two variables referring to the attractive features of the Islands – trekking and nature – permit the convergence.[7] Table 5 summarises the results of both the barrier model calculations.

Table 5. Hurdle models, Poisson and BN2 distributions

	POISSON				BN2			
	Truncated		Election		Truncated		Election	
	Coef	P-valor	Coef	P-valor	Coef	P-valor	Coef	P-valor
Constant	1,50	0,16	-5,50	0,04	1,45	0,68	-6,03	0,08
Km	-1,25	0,25	-4,21	0,01	-1,85	0,25	-6,98	0,02
Rel	-2,07	0,03	3,42	0,22	-2,47	0,48	3,84	0,28
Info	0,34	0,08	-0,01	0,98	0,40	0,33	0,27	0,67
Remu	0,83	0,00	-0,39	0,41	0,74	0,08	-0,43	0,47
Green	-1,03	0,02	0,07	0,95	-0,75	0,46	0,80	0,65
Know	1,90	0,00	1,11	0,23	2,05	0,02	1,98	0,10
Child	-0,72	0,00	0,16	0,73	-0,73	0,05	-0,01	0,98
Conta	0,58	0,03	1,69	0,00	0,81	0,10	2,30	0,01
Beach	0,22	0,23	1,08	0,09	-	-	-	-
Tranq	-0,20	0,34	2,35	0,00	-0,41	0,20	2,72	0,00
Age	-0,52	0,42	-2,75	0,04	-0,65	0,66	-4,06	0,03
Income	-0,24	0,73	5,81	0,00	0,24	0,88	8,37	0,01
Overdispers.	-	-	-	-	0,53	0,25	0,84	0,22

With the single exception of the beach variable not being significant in the BN2 model, the remaining coefficients are very similar for both Poisson and BN2 in the two stages of the estimation. There are more significant regressors in the Poisson model - which would indicate non-observed heterogeneity among the respondents - and the BN2 model would therefore be preferable even though the over-dispersion coefficient may not be significant. For these reasons, and given that the coefficients are similar, we interpret the BN2 model. A first result is that the sets of significant regressors for the truncated model and for the discrete model are quite different. This fact supports the hypothesis that the two decision processes (to go or not to go, and how often to go) are qualitatively different. Hence, a similar handling of the 93 non-visitor zeros and the 87 visitor values would be erroneous, given that they correspond to distinct data-generation processes.

The fact that *age, income,* and *distance* are very significant in the decision to visit is clearly intuitive. These variables play no part in explaining the displacement of

[7] These two variables were never significant in the demand estimations for the sample of visitors. Nor were they significant when the probability of being a visitor was measured separately via a dichotomous model.

those who visit the nature area; on the other hand, *child, remu* and *know* play an important part in the number of displacements but not in the decision to visit. The only factor which continues to be significant both in the decision to visit and in the number of visits is the absence of pollution (*conta*), an important feature of the Islands. Finally, the other regressors do not play a clear role in the two decisions modelled here.

In Table 6, we can see that it is not clear that the BN2 model dominates the Poisson model, since the over-dispersion coefficient is not significant and likelihood is not improved. Nevertheless, it is clear that the hurdle model is more appropriate for describing these data in that its verisimilitude is clearly an improvement on the survey model. We can affirm that the preference structure for visitors is qualitatively different from that for non-visitors and the observations that we have for the non-visitors are of no value in calculating the consumer surplus. It can thus be concluded that an *in situ* sample is preferable to a representative sample of the population.

Cuadro 6. Log-likelihood and over-dispersión coeficients

MODELO	DISTRIBUTION		LOG – LIKELIHOOD	OVERDISPERSION *
Recuento	Poisson		-204,71	
	BN2		-199,85	0,25 (0,16)
Hurdle Models	Poisson	Election	-51,83	
		Truncated	-125,59	
		Conjunto	-177,43	
	BN2	Election	-53,113	0,53 (0,25)
		Truncated	-121,4	0,84 (0,22)
		Conjunto	-174,53	

* P-value in brackets

5. Conclusions

With respect to the objectives laid down in the introduction, the best demand prediction results were obtained with an *in situ* sample, with a truncated or *in situ* treatment of the sample, with an average demand defined in terms of number of visitors to the area of nature, and with a displacement cost that includes all the costs incurred in the visit. The variation in results in terms of the consumer surplus would indicate the importance of making comparisons between various demand models.

We feel unable to make a judgement in respect of truncated handling versus *in situ* handling of the sample. This is probably due to the peculiarities of our sample; the majority of visitors made just one visit in five years, and therefore the truncation effect is more important for describing the sample than the frequency modifications of the higher visit numbers. In other words, the *in situ* handling supplies to the estimation process the information that the sample is truncated (which is the essential information). The fact that it corrects, in addition, the frequencies of the higher visit numbers changes the demand configuration only marginally. Hence it is quite possible that in other samples in which the proportion of one-time visitors is less important, *in situ* handling might obtain better predictions than truncated handling. In the same way, the number of visits in this sample is characterised by equi-dispersion (a variance approximately equal to the mean), and it is therefore only to be expected that the negative binomial distribution does not obtain better results than the Poisson distribution. For a sample not characterised by equi-dispersion, it is quite possible for the results obtained here to be reversed. Again, these issues highlight the importance of comparing different kinds of models.

Finally, it was proven that non-visitors may have a preference structure that is qualitatively different from that of visitors, and that therefore, when estimating a consumer surplus for the demand for an area of nature, only one sample is necessary.

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Appendix 1: Consumer surplus for the Poisson or BN2 models with costs expressed in logarithms

Proposition. In a Poisson or BN2 model with expectation $\lambda = \exp(\alpha + \beta \ln p)$, where α and β are parameters and p is the cost, the consumer surplus is infinite except for values of β less than -1.

Proof. The surplus (EC/CS) of a consumer having such expected demand is

$$\text{EC} = \int_p^{+\infty} E(Y \mid X)dp = \int_p^{+\infty} \exp(\alpha + \beta \ln t)dt = e^{\alpha} \int_p^{+\infty} t^{\beta} dt$$
$$= e^{\alpha}\left(\infty^{\beta+1} - p^{\beta+1}\right)/(\beta+1) = \infty \ \forall \ \beta > -1.$$

Appendix 2: Definitions of displacement costs

On the basis of the following costs, seven displacemement costs are defined:

Table 7. Costs incurred (respondent estimations)

1. TIM1: Length of return journey from home to temporary residence in Galicia
2. C1: Cost per person per return journey from home to temporary residence
3. DOUT: Number of days spent away from home
4. COUT: Cost per person per day for accomodation

These 4 variables were always zero for visitors who went directly from home to the ferry port of the Cíes Islands.

5. TIM2: Length of return journey from home to ferry port
6. C2: Cost per person per return journey from home to ferry port
7. CB: Cost of return ferry boat journey to the Islands
8. DISL: Number of days spent on the Islands
9. CISL: Cost per person per day for the stay on the Islands (in excess of 1 day)

Auxiliary to cost variables:
Disf: Dichotomous variable indicating whether the visitor considers the journey in (5) to be enjoyable
Mot: Dichotomous variable indicating whether the main reason for being in the Autonomous Community of Galicia is the journey to the Islands

Ca Total cost, including nights of arrival and departure
= ((Tim1*1063 + C1) / DOut + 2*COut + (Tim2 + 2)*1063 + C2 + CB) / DIsl1 + CIsl

Cn Does not take into account nights spent away from the Islands = ((Tim1*1063 + C1) / DOut + (Tim2 + 2)*1063 + C2 + CB) / DIsl1 + CIsl

Cc Displacement from home to ferry port is only a cost for those who declare it so = ((Tim1*1063 + C1) / DOut + 2*COut + (1 - disf)*(Tim2 + 2)*1063 + C2 + CB) / DIsl1 + CIsl

Cd The length of stay on the Islands is irrelevant (these can be visited in a day)
= (Tim1*1063 + C1) / DOut + 2*COut + (Tim2 + 2)*1063 + C2 + CB

Ct The opportunity cost of time is null (Spanish labour market inflexibility)
= (C1 / DOut + 2*COut + C2 + CB) / DIsl1 + CIsl

Cm The cost of getting to the temporary residence (Tim1, C1, COut) is only counted for those visitors whose principal motive for travelling is the visit to the Islands = (Mot*((Tim1*1063 + C1) / DOut + 2*COut) + (Tim2 + 2)*1063 + C2 + CB) / DIsl1 + CIsl

Tim, C The monetary and time costs are considered separately

Tim = Tim1 / DOut + Tim2 + 2
C = C1 / DOut + C2 + CB

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