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Economic valuation of environmental services in forests of *Nothofagus Alessandri* (Ruil): an application of the choice experiment method, Region del Maule, VII Region, Chile

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Introduction

Environmental services are those services provided by nature for people, generating indirect profit to consumers such as scenic beauty and the biodiversity living within the ecosystems (Perez, 2002).

In the area of rural development, the use of environmental assets is strongly tied to the economic well being derived from them. Therefore, the preservation of renewable resources such as native forests is a contribution to the socio economic improvement of the communities possessing such resources. In the search for a way to develop in accordance with nature, there emerges the need to estimate the value of the environmental services in order to generate economic mechanisms for the preservation of the resource (IICA, 1999). This estimate will permit calculating what the optimal level of economic incentives should be to effectively produce at the private level the changes of behavior that redirect the use of the resource.

The Ruil (*Nothofagus Alessandri*) is a forest species endemic to the VII Region of Chile (Latitude 35° 25' 59''S; Longitude 71° 40' W) being one of the ten species of South American native beech trees/*fagaceae*. It has been recognized as a primitive member of the *Nothofagus* genus, and is considered by the UICN as a world Hotspot since it is the only place in the world where 390 hectares of this species are still preserved. According to Donoso's studies (1993), the populations have been decreased by almost 60% between the years 1983 and 1999 as a result of establishing *Pinus radiata* plantations. As of 1985, the Chilean National Forest Corporation (CONAF) declared the Ruil an endangered species in need of protection (CONAF, 1989). The current survival of the species is being favored by the type of habitat and its capacity for vegetative regeneration. Given the facts just mentioned, the efforts toward preservation and valuation of the species are well justified.

The main objective of this investigation was to estimate the marginal willingness to pay (WTP) for attributes related to environmental services supplied by this forest resource in the nearby communities. To this purpose the Choice Experiment method was applied because it allows evaluating the relative importance of each one of these attributes. The method has been applied in other investigations related to protecting biodiversity, conservation of wilderness areas, and satisfactory administration of natural resources (Morancho, 2001; Riera, 2004; Windle & Rolfe, 2005; Cerda, 2005).

Methodology

The research was carried out in the Empedrado and Chanco districts located in the costal dry lands of Chile's VII Region. The social demographic attributes of a sample of 160 families were defined. The selection model is based on the idea that a good can be described in terms of its attributes and the degree of availability that each service supplies. A variant of this model is the Choice Experiment Method, which allows estimating the interviewed person's marginal willingness to pay according to the attributes linked to the environmental services generated by the Ruil forest. The three valued attributes were: the area of the Ruil forest effectively protected, the scenic beauty given by this forest resource, and the implementation of protection and conservation programs for the flora and fauna inhabiting the Ruil forest.

The method consists of presenting the interviewee with a group of scenarios that have common predetermined attributes, one of which is monetary. Each one of these attributes has different levels, the combinations of which make up the different scenarios to be evaluated by the interviewee. One of these scenarios represents the Status Quo (SQ) or current situation of each one of the valued attributes. Table 1 shows the selected attributes and their respective levels.

Table 1: Attributes and levels

Surface area effectively protected (ha)	Scenic beauty	Conservation of plant and animal species	Monthly fee to protect the Ruil (USD)
24.7 (SQ)	1 path (SQ)	No programs for conservation of pudu, copihue, woodpecker (carpinterito) and pitao (SQ)	0 (SQ)
170	2 paths and 2 view points	Only programs for conservation of the pudu and the copihue exist in the entire Ruil forest area.	5.7
339	2 paths, 2 view points plus information leaflets and guided visits	Programs for conservation of the pudu, the copihue, the carpinterito and the pitao are available in the entire Ruil forest area.	11.4

Source: prepared by the authors

A means of payment was designed to facilitate the response of the interviewee regarding his willingness to pay for each one of the proposed scenarios. It was suggested that the money raised would permit financing an Environmental Protection Fund directed exclusively to the protection of the Ruil through the implementation and maintenance of the scenario preferred by the surveyed people. The money collected monthly would be managed by a technical team, which, together with collecting the money, would charge for the basic power and water services.

Once the attributes and their respective levels of availability were defined, the scenarios to be used in the questionnaire were selected. The design of the choice experiments requires three types of valuation scenarios to be prepared. A first scenario, which is denominated card A, represents the first scenario different from the current one. Given that there are 4 attributes and 3 levels for each of them, there is a total of 81 possible A cards (3^4). Because of the high number of A cards (81), an approximation was looked for in order to decrease their number so that the choice experiment would be manageable. An orthogonal design (fractional factorial design) was carried out, through which 9 A cards were obtained. Each A card represents the first scenario different from the current situation, to become part of each of the 9 choice sets.

The second type of valuation scenario, called card B, is obtained through an adaptation of the fractional factorial design called "shifting". In other words, it consists of taking an A card and changing the levels of its four attributes to one degree or level higher. This operation is carried out with each of the 9 A cards, getting 9 B cards as a result.

In order for the choice set to be complete, it has to have a third type of scenario (card C), which represents the current situation – SQ in which the Ruil forest resource is found. The objective of the exercise is that each card gives to the interviewee a certain level of profit where:

$U_1 = F(x)$ of the attributes and levels of card A

$U_2 = F(x)$ of the attributes and levels of card B

$U_3 = F(x)$ of the attributes and levels of card C

and where U represents the profit.

The logic of the analysis lies in that the interviewee will have to choose the card giving him the greatest profit; that is, if he chooses U_1 it will be because $U_1 > U_2 > U_3$. The profit function U_j has the following form:

$$U_j = \beta_{\text{AREA}} \Delta \text{AREA} + \beta_{\text{SCENIC BEAUTY}} \Delta \text{SCENIC BEAUTY} + \beta_{\text{SPECIES}} \Delta \text{SPECIES} + \beta_{\text{FEE}} \Delta \text{FEE},$$

where β are the estimated coefficients and Δ represents the degree of difference there is between two levels of the same attribute, determined by the interviewee's choice. One attribute's marginal willingness to pay is calculated as the coefficient of the estimated parameter divided by the negative coefficient of the price (Riera, 2004). For instance, keeping the profit constant, the marginal WTP for an increase in the area of Ruil forest effectively protected will be:

$$\text{WTP marginal} = \frac{\beta_{\text{AREA}}}{-\beta_{\text{FEE}}}$$

To analyze the information, the commonly used statistic model for estimating the results of the choice experiments is the conditional logit model. This study presents the conditional logit model estimation of the main effects, using the Limdep multinomial logit model software. Moreover, a correlation analysis (Pearson) was made between the demographic variables and the attributes chosen by the interviewees. The SPSS 12.0 software was used to get the respective correlations between attributes and the socio-demographic variable.

Results

A total of 160 people were interviewed, of whom 98 were woman (61%) and 62 were men (39%). The interviewees' average age was 42 years. Of the people interviewed, 41% had at least 9 to 12 years of education, equivalent to an incomplete secondary level. Of the people interviewed, 35% had an income inferior to the Chilean minimum wage, equivalent to US\$ 280. Seventy-one percent of the interviewees declared knowledge of the Ruil forest. The most important attributes for the interviewed people were the area of Ruil effectively protected (49%) and the implementation of protection and conservation programs for species inhabiting the Ruil forest (35%).

The β presented in Table 2 represent the coefficients obtained from the conditional logit model. It can be noted that the significant attributes were surface area ($\beta = 0.677$) and recovery and conservation of the species ($\beta = 0.319$). Consequently, marginal WTP values of US\$ 1.45 and US\$ 0.70 monthly were obtained for the attributes "area protected" and "conservation of species", respectively. The scenic beauty attribute was not statistically significant for the community ($p = 0.7164$).

Table 2: Discrete option (multinomial logit)

Variables	Coefficientes (β)	Significance ($P\{ Z >z\}$)
Surface area	.6777669890	.0000*
Scenic beauty	-.2541143220E-01	.7164
Conservation of species	.3194638967	.0000*
Cost	-.8614114642E-03	.0000*

* Variable significant to level 0.05

Source: prepared by the authors

The variables age, education and income showed a significant relation to the choice of levels proposed for each attribute, which makes clear the importance of these variables in the valuation of environmental services.

Tabla 3: Correlation between the demographic variables and the cards chosen

	Gender	Age	Education	Income
surface area chosen	-.012 (.646)	-.103(**) (.000)	.175(**) (.000)	.165(**) (.000)
scenic beauty chosen	.007 (.793)	-.103(**) (.000)	.147(**) (.000)	.127(**) (.000)
species chosen	.004 (.873)	-.124(**) (.000)	.183(**) (.000)	.170(**) (.000)
choice cost	.001 (.966)	-.119(**) (.000)	.247(**) (.000)	.269(**) (.000)

** The correlation is significant to level 0.01 (bilateral).

Source: prepared by the authors

Conclusions

The study permitted the identification and description of relevant environmental services associated with the Ruil forest.

It can be seen that the surveyed sample had a good knowledge of the evaluated resource and at the same time were willing to participate in a conservation plan.

It must be mentioned that the method used in the study permitted an adequate valuation of the willingness to pay (WTP); this aspect being comprehensible to the interviewees.

In contrast to other methods, the choice experiment method allows determining the independent effect of each of the environmental services (evaluated attributes).

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