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AGRICULTURAL UNIVERSITY OF SZCZECIN
FACULTY OF ECONOMICS AND ORGANIZATION OF FOOD ECONOMY

MODELLING OF ECONOMY IN SPECIALLY PROTECTED REGIONS

Proceedings of the international conference held on 9-11 june 1994 in Drawno, Poland

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EVALUATION OF THE FOREST LANDSCAPE USING DICHOTOMOUS CHOICE MODEL

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1. Introduction

Interest in natural resources has increased considerably over the past decades, and concurrently, there have been great advances in their management. With specific reference to forest resources, the objective role of the public agency has expanded beyond the primary function of timber production to include the other functions of the forests: landscape, hydrological defense, etc.

Thus, there have been changes in the parameters taken into consideration by the public decision maker when analyzing proposals for interventions that have repercussions on the resources in terms of benefits as well as social costs. We must be able to quantify those benefits in order to be able to take them into account during the economic analysis of the interventions. This paper summarizes the first results of a study aimed at quantifying the benefits deriving from the transformation of the main

crops in an Appennine forest near Florence through the analysis of the resource users preferences and willingness to pay.

The purpose of the study is to give the public decision maker some indication of the public's preferences through an estimate of the mean value of the various hypotheses for changing the forest landscape: from fir high forest to beech (and vice versa) from chestnut coppice to pine groves (and vice versa).

After a brief introduction to the forest studied (section 2) we will describe the methods used (section 4) and then go on to a discussion of the results obtained (section 5).

2. Object of the study: The Vallombrosa Forest

The area under evaluation is the State Forest of Vallombrosa which was declared a natural biogenetic reserve in 1977. Notwithstanding the fact that the area of this resource is relatively modest as it covers about 1,270 hectares, it plays a significant role as regards its potential for outdoor recreation for the local population. The forest is situated in the Tuscan Appennines about 40 kilometers from the center of Florence.

The Vallombrosa forests are almost entirely artificial in origin. The percentage breakdown of the crops comprises more than 50% of silver fir high forest, 15% beech coppices which are currently being converted into high forest, slightly more than 11% Austrian pine and with the rest consisting of minor species including Douglas fir and chestnut.

For a long time timber production was the main objective in the management of the Vallombrosa forest. In recent decades, however, following economic and social changes, recreation,

environmental conservation, scientific research, etc. have taken a primary position with respect to timber production. For approximately thirty years production has decreased 64%[1] while the number of visitors to the forest has increased by 60%.

Management objectives and goals have changed along with society's needs. One of these objectives, namely the, outdoor forest recreation, plays a decisive role in the analysis of potential action/intervention plans. The importance of knowing the users' preferences with regard to different types of crops is evident.

3. Evaluation of the forest landscape at Vallombrosa

In order to evaluate the forest landscape we carried out a cognitive survey based on observations of visitors' behavior at the Vallombrosa forest, and direct interviews of a sampling of users. In order to determine the number of interviews to be conducted we did surveys during the period of major visitor traffic (15 June - 30 September 1993). Therefore, we arrived at an estimate of approximately 60,000 visitor-days during the period of analysis which were concentrated mostly at the weekends when an average of 85% of the visitors came to the forest (table 1). This is a feature peculiar to recreational resources located near major cities, and at the same time with considerable unique features from the qualitative-quantitative standpoint *(Clawson and Knestch, 1966)*.

[1]Currently, only phytosanitary cutting is done in the Vallombrosa forest.

Table 1: Estimated visitor turnout for concentrated recreation from 15 June-30 September 1993

Turnout per typical-week			*Number of days for the survey period*		*Estimated turnout during the period*
Monday	70	2,02%	Monday	15	1.150
Tuesday	86	2.49%	Tuesday	15	1.390
Wednesday	62	1,79%	Wednesday	15	930
Thursday	14	0,40%	Thursday	15	210
Friday	1.020	29,49%	Friday	15	15.300
Saturday	534	15,44%	Saturday	16	10.544
Sunday	1.672	48,36%	Sunday	16	27.760
total	3.458	100,00%	total	107	57.284

(a) Not counting visitors over the Ferragosto (august 15) holiday

It is important to note that only 75 hectares of the forest are used for outdoor recreation[2]; it is an area with generally flat ground, with no undergrowth and located near the major roads and paths leading into the forest.

It is also interesting to note that most of the area now used for outdoor recreation was not specifically set aside for this purpose in the previous organization plan. This area was more or less taken over as a result of the increased demand for outdoor recreation on the part of the users.

The interviews made it possible to draw up a profile of the average visitor to Vallombrosa: 69% of the visitors range from 20 to 45 years of age; over 55% come from families with less than three members; only one quarter of those interviewed are self-employed, while one sixth hold university or higher degrees; that great majority (over 95%) of the visitors comes from Tuscany (4/5 from Florence Province) and in 2/3 of the cases need

[2]The main user activities during visits to Vallombrosa are passive (cfs. Clawson and Knetsch, 1966): over 60% walks, 40% picnics and 22% resting.

to travel less than 1 hour to reach Vallombrosa; therefore, nearly all (93% approximately) the visitors come to the forest with their own transportation.

As to the visitors' recreational preferences, it should be noted that over half of those interviewed said that they had previous hiking experience, and approximately 1/3 go hunting, fishing and/or on photographic excursions. Generally, 20% of the interviewees preferred mountain environments and another 20% the hills, especially if there are forests, when choosing vacation sites; one fourth go camping (trailers and/or mobile homes) on vacation. About 40% of those interviewed were at Vallombrosa for the first time.

The main features which, in the opinion of the interviewees, affect the quality of their visits to the forests and Vallombrosa in particular are: availability of infrastructures and facilities (41%), lack of crowds (31%) and the type of crops (24%).

With reference to the first item we should point out that the majority of the interviewees emphasized the need for improving infrastructures and facilities, and made it quite clear that such improvements should not be to the detriment of the "natural" qualities of the environment. What they want is a support role, a minimal logistical reference: larger rest areas, more information, the creation of a medical emergency unit, etc.

With reference to crowding, we must state that this has not been considered yet as a piority issue among the visitors to Vallombrosa. In general; only 1/3 of the interviewees said that the quality of their recreational experience was negatively affected by exessive numbers of visitors, and the number of contacts with such visitors did not seem excessive, especially when compared with other similar sites, if we consider that on the most crowded days half of these visitors met less then 1,000 people. About 80%

of those interviewed did not consider Vallombrosa overcrowded with visitors.

Table 2: Preferred forest landscapes at Vallombrosa National Forest

Order of Preference	*High silver fir forest*	*High beech forest*	*Chestnut coppice*	*High austrian pine forest*	*Total*
1.	43,97%	24,45%	6,7%	23,88%	100,00%
2.	23,66%	28,35%	24,11%	23,88%	100,00%
3.	20,09%	30,08%	25,89%	23,22%	100,00%
4.	12,28%	15,40%	43,3%	29,02%	100,00%
Total	100,00%	100,00%	100,00%	100,00%	

Finally, of the four most common crops at Vallombrosa, the interviewees stated their preference (table 2), in order, for fir, beech and pine groves and chestnut coppices.

4. The close-ended approach

In our estimate of the recreational benefit of the Vallombrosa forest we used the close-ended approach according to Hanemann (1984). The purpose was to arrive at an estimate of the WTP for the possible transformation of one hectare of a given crop into another. The development of this set-up leads to an estimate of the variation of prosperity for Vallombrosa visitors corresponding to a Hicksian measure of compensative surplus (CS) in the event the transformation offer is in line with the visitor's preferences[3] or to the equivalent (ES) in the opposite case (table 3).

[3]There is, therefore, an improvement in welfare.

Table 3: Compensated measure of welfare

Variation in welfare	*Willingness to pay*	*Willingeness to accept*
Increase	CS will not forego	ES will forego
Decrease	ES avoid	CS accept

The value of the sought utility is correlated to the distribution of the dichotomic variable YES/NO, represented by the responses to the offers proposed to the interviewees. For example, in the case of an improvement, the probability distribution of that random variable can be identified by the equation:

$$Pr_1 = Pr(SI \mid OFF) = Pr\{v_1(1, y - OFF; a) + \varepsilon_1 \geq v_0(0, y; a) + \varepsilon_0\} =$$

$$Pr\Delta v + \mu \geq 0 = Pr\mu \geq -\Delta v \qquad (0.1)$$

with $\mu = \varepsilon_1 - \varepsilon_0$, and $\Delta v = v_1 - v_0$;

where y is the visitor's income, OFF is the amount of money the individual would pay in order not to forego or to avoid the hypothesis of transformation stated in the questionnaire, a is a vector of the characteristics that could influence the typical preferences of each individual[4], v_1 and v_0 are the indirect functions of utility (post- and pre-improvement, respectively) and finally represents a normally distributed random error with a mean 0 and a variance of 1.

If $F_\mu(.)$ represents the c.d.f. of μ the probability of the WTP is identified by the equation:

$$Pr_1 = f\mu(\Delta v) \qquad (0.2)$$

[4]These characteristics are age, sex, education, etc.

if the offer is accepted, or by:

$$Pr_0 = PR(NO = 0 \mid OFF) = 1 - F_\mu(\Delta v) \tag{0.3}$$

if the offer is refused.

In this paper the c.d.f. we used is represented by the standardized logistic (*Logit* Model) according to:

$$F_\mu(\Delta v) = \frac{1}{1 + e^{-\Delta v}} \tag{0.4}$$

For the prosperity variation (*BISHOP and HEBERLEIN, 1979 and 1983; HANEMANN, 1984; BOYLE and BISHOP, 1988; SELLAR, 1985 and 1986)* we used two different functional forms:

Model 1: $\Delta v = \alpha + \beta \cdot OFF$

Model 2: $\Delta v = \alpha + \beta \cdot ln(1 - OFF/R)$

However, how can we resolve the estimate of these relations? Hanemann (1984) says that the individual will agree to pay the amount OFF only if his "real" WTP, which in the case of an improvement is represented by the compensative surplus (CS) is greater than the OFF, vice versa in the opposite case:

$$Pr_1 = Pr(SI = 1 \mid OFF) = Pr(WTP > OFF) = 1 - G_C \tag{2'}$$

$$Pr_0 = Pr(NO = 0 \mid OFF) = Pr(WTP \leq OFF) = 1 - Pr_1 = G_C \tag{3'}$$

where G_C is the c.d.f. of CS. By comparing (2') and (3') with

(2) and (3), respectively, we can see that $F_\mu(.)$ is equal to the probability that $ES > OFF$, that is $F_\mu[\Delta v(OFF)] = 1 - G_C$; therefore, to resolve (2) we merely need to identify the parameters of the c.d.f. $(1 - G_C)$.

We identify CS by calculating the mean[5] value of the distribution of $G_C(OFF)$ according to:

$$E[CS] = \int_0^\infty [1 - G_C(OFF)]dOFF = \int_0^\infty F_\mu[\Delta v(OFF)]dOFF \qquad (0.5)$$

or its median value:

$$F_\mu(CS_{0,5}) = 0,5 \qquad (0.6)$$

5. Results of the analysis

The aim of this study was to estimate the WTP of the Vallombrosa visitor forest to transform one hectare of crop to a preferred species, and measure the compensative surplus (CS) or the WTP to avoid transforming the crop into a less desired type, and in that case measure the equivalent surplus ($ES, cfr.$ table 3).

The choice of the WTP was rendered necessary because, according to several authors *(RANDALL* and *STOLL, 1980; KUTRILLA* and *FISCHER, 1975; NG, 1983: ROMANO D.* and *CARBONE F. 1993)* this is more indicated that the WTA for the estimate of the benefits deriving from an increase or from the maintenance of an

[5]If the value of the higher integration extreme is ... the f.d.c. must be normalized to assure that the calculated integral value is equal to 1(Boyle et al., 1988)
$E[CS] = \int_0^{OFF^*} [1 - K \cdot G_C(OFF)]dOFF$
where $K = 1/OFF^*$ is the normalization constant.

offer of environmental assets which, in fact, is the situation we hypothesized in our interviews.

We conducted a survey on a sampling of 600 visitors using direct interviews (specially prepared questionnaires).

Through the questions we tried to have the interviewees express a preference with regard to the four most common crops in the Vallombrosa forest:

A) high silver fir forest
B) high beech forest
C) chestnut coppice
D) Austrian pine.

Then, we hypothesized the creation of a club in which members could participate in decisions concerning possible environmental improvements to be made in the forest. We asked about willingness to pay for a given offer, with a membership fee ranging from Lit. 10.000 to Lit. 100.000. We made clear that the membership fee would be used only to transform one given crop into another.

The hypothesized transformations were:

silver fir forest into beech forest	$A \rightarrow B$
beech forest into silver fir forest	$B \rightarrow A$
chestnut coppice into pine forest	$C \rightarrow D$
pine forest into chestnut coppice	$D \rightarrow A$

Tab. 4. Estimated *WTP* for the hipothesized conversion (Lire)

		Compensative Surplus		Equivalent Surplus	
Revealed preference	Hipothesized Conversion	model 1	model 2	model 1	model 2
Silver	B → A	42.000	27.800		
	A → B			49.000	37.000
Beech	A → B	47.500	46.500		
	B → A			72.000	58.500
Chestnut	D → C	34.000	21.500		
	C → D			48.000	57.500
Austrian pine	C → D	40.500	25.000		
	D → C			36.000	39.000

We used the two models described above to calculate the Δv for all four cases. Starting from the preferences expressed, we estimated the *WTP* for improvement, in accordance with the preferences noted[6], and as well as for worsening[7] (Table 4). First of all, we must note that the *ES* was always slightly higher than the *CS*, and that this difference was greater when we used the second model[8]. Theoretically they should be equal (*HICKS*, op. cit.) but in practice they can differ even considerably especially in the case of assets characterized by unique and unrepeatable features such as environmental assets. According to some authors the reason for this is in behavioral asymmetries which are typical of human nature and which call into play the different perceptions that individuals may have of the same variation in prosperity according to whether they view it as an improvement or worsening with respect to the initial conditions *(KAHNEMAN* and *TVERSY, 1979)*. In fact, there is less willingness on the part of the consumer, and therefore greater willingness to pay, when

[6] In this case we hypothesized an increase in the forest area preferred by the visitor.

[7] In this case we asked the visitor the *WTP* to prevent a decrease in the preferred forest area

[8] This model, as formulated, takes the visitor's income into account.

it comes to foregoing something he already has as opposed to paying for something he does not possess yet. This is one of main reasons for which it is advisable to perform both measurements in order to identify the range of variation within which the sought-for value certainly is. We should also point out how the consumer's income, used in the second model, has a greater effect on defining *WTP* in the *ES* estimate as opposed to the Cs version. This also can probably be traced to the reasons outlined above.

Among the various hypotheses, the transformation preferred by the interviewed visitors is from high silver into beech forests. The *WTP* in this case is Lit. 47.500 as opposed to Lit. 42.000 for the reverse transformation. This is also confirmed by the *WTP* of Lit. 72.000 to prevent one hectare of beech from being transformed into silver fir. This is closely correlated with the features of the forest under review: the high beech forests, where there is no thick undergrowth, and with leafy trees are particularly suited to recreational activities such as walks in the woods, picnics, etc.

The lower estimated value for the transformation from high Austrian pine to chestnut coppice can also be attributed to the same reasons: the excessive density that frequently characterizes chestnut coppices and the lack of fruit production are factors that certainly go against this type of crop.

As we have seen, in our case *CS* and *ES* measurements are different, even if the deviations are limited. The actual landscape value falls somewhere between the two measurements. Since we cannot quantify that value with any great accuracy, which of the two measurements would be appropriate to be used?

The theoretical results obtained up to now allow us to affirm that the "correct" measure of the benefits of such actions, that is, the one consistent with *KALDOR'S (1939)* and *HICKS' (1939)*

principles is represented by *CS*.

Hoehn and *Randall (1987)* have, in fact, shown that a correct cost benefit estimate should make it possible to identify all the proposals that do not generate potential Paretian improvements[9], and at the same time, should identify at least one subset of those which do induce such an improvement. Therefore, we can conclude that a cost-benefit estimate that shows *WTP* estimates that do not exceed their "true" value can be considered satisfactory.

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[9] An action is consistent with the potential Paretian improvement criterion if the value of the benefits obtained by whoever improves his condition is greater than the value of the cost incurred by the one whose condition is worsened.

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