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PARTICIPATION OF NON-INDUSTRIAL PRIVATE FOREST OWNERS IN NATIONAL FOREST PROGRAMMES: A DISCRETE CHOICE MODEL FOR NORTHERN PORTUGAL

Américo Mendes

Universidade Católica Portuguesa (Porto)

Participation of non-industrial private forest owners in National Forest Programmes: a discrete choice model for Northern Portugal[1]

Américo M. S. Carvalho Mendes

Portuguese Catholic University
Faculty of Economics and Management
Rua Diogo Botelho, 1327
4169-005 Porto - Portugal
Tel. +351-2-6196294 / Fax +351-2-6196291
amendes@porto.ucp.pt

Abstract: In countries where private forest ownership is very important, knowledge of the behaviour of private forest owners is useful for the design and implementation of successful forest policies. This applies to Portugal where 86 % of the forest lands are private property. This paper presents a study carried out in a region of the Northern part of the country covered by a local forest owners' association. Based on individual data about the members of this association concerning some of their characteristics (implementation of publicly subsidised afforestation projects, size of the forest holdings, number of forest holdings belonging to the same owner and distance between the permanent residence of the owner and his forest holdings), a multinomial logit model is estimated for the probabilities of participation on public incentive schemes to finance individual and grouped afforestation projects.

Keywords: non industrial private forest owners, afforestation projects, public incentives

Introduction

In Portugal 85.7 % of forest lands are under private management, the rest being almost entirely communal forests managed by the Forest Services. Except for one third of the eucalyptus plantations managed by the pulp and paper companies, almost all the remaining private forests belong to non industrial private forest owners (NIPFO). Therefore understanding the behaviour of this type of owners is important for forest policy design and implementation.

In this paper we take up the issue of participation of NIPFO in the public incentive schemes financing afforestation and improvement of existing stands[2] as described in Mendes (1998). The regional setting for this study is the area called Sousa Valley, located about 30 km eastwards from the city of Oporto. This zone has a

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[1] Paper presented at the Forest Policy Research Forum "The role of National Forest Programmes to ensure sustainable forest management", 14-17 June 1999, European Forest Institute, Joensuu (Finland).

[2] To make the writing shorter, hereafter when we talk about "afforestation projects" we mean not only projects for afforestation, but also projects for improvement of existing stands.

total of 36249 ha of forests, mostly maritime pine and eucalyptus globulus, and more than 7200 forest owners, most of them with small forest holdings.

Theoretical model of the forest owners' behaviour

Based on a data set with information about some characteristics of a sample of 383 NIPFO of the Sousa Valley, the purpose of this paper is to investigate the factors influencing the probability they have to carry out an afforestation project which applied for the public incentive schemes available for this purpose. The common set of observed characteristics of the individual forest owners will be summarised by a vector *s*.

The set of mutually exclusive alternatives available to an individual forest owner are the following:

- he can carry out an individual afforestation project only;
- he can join with his neighbours to carry out a grouped afforestation project;
- he can do both types of projects;
- he can just keep his forest lands as they are, without any project.

The set of observed attributes of each of these options will be summarised by a vector *x*.

Following Domencich and McFadden (1975), we will assume that the individual behaviour of the forest owners is consistent with a well-defined stochastic utility function $u = U(x, s, \varepsilon)$ where ε is a random vector containing all the unobserved attributes of the alternatives and characteristics of the forest owners.

Assuming the forest owners are utility maximizers, each of them will choose the alternative i if this is the one which yields the highest utility among those available for choice which is denoted as follows, after dropping the random vector ε to simplify the notation:

(1) $U(x_{ki}, s_k) > U(x_{kj}, s_k) \qquad j \neq i,\ j = 1, \dots, n$

where k denotes the forest owner and n denotes the number of alternative choices available to him, which is equal to four in our case.

Continuing with the approach presented in Domencich and McFadden (1975), let P_{ki} be the probability that individual k chooses the alternative i. For empirical work we need to come to an explicit functional form for these choice probabilities. To get there, the random utility function $U(x, s)$ can be decomposed into a stochastic term $\eta(x, s)$ and a non-stochastic term $V(x, s)$. With this decomposition, the choice probabilities P_{ki} can be written as follows:

(2)
$$\begin{aligned} P_{ki} &= P\left[U(x_{ki}, s_k) > U(x_{kj}, s_k) \quad j \neq i, \quad j = 1, \dots, n\right] = \\ &= P\left[V(x_{ki}, s_k) + \eta(x_{ki}, s_k) > V(x_{kj}, s_k) + \eta(x_{kj}, s_k) \quad j \neq i, \quad j = 1, \dots, n\right] = \\ &= P\left[\eta(x_{kj}, s_k) - \eta(x_{ki}, s_k) < V(x_{ki}, s_k) - V(x_{kj}, s_k) \quad j \neq i, \quad j = 1, \dots, n\right] = \\ &= F\left[V(x_{ki}, s_k) - V(x_{kj}, s_k) \quad j \neq i, \quad j = 1, \dots, n\right] \end{aligned}$$

where F is the cumulative joint distribution function of $\left[\eta(x_{k1}, s_k), \dots, \eta(x_{kn}, s_k)\right]$.

Empirical model

A well known result proved by McFadden (1974) is that, if we assume the random variables η have independent Weibull distributions, the choice probabilities have the following expression:

$$(3)\ P_{ki} = \frac{e^{V(x_{ki}, s_k)}}{\sum_{j=1}^{n} e^{V(x_{kj}, s_k)}}$$

This is known as the conditional logit model. For econometric estimation a linear approximation of the function V is usually taken.

$$(4)\ V(x_{ki}, s_k) = \beta_i' s_k + \gamma' x_{ki}$$

The data set available for this study does not contain a mixture of individual and choice specific information which means that the variables x_{ki} are unobserved. Only some components of the s_k vectors are observed, more precisely the following ones:

- size of the forest holdings measured in hectares (A);
- number of forest holdings (H);
- distance between the permanent residence of the forest owner and his main forest holding measured in kilometres (D).

The descriptive statistics for these variables are presented in table 1.

Table 1: Descriptive Statistics of the individual characteristics of NIPFO

Variables	Minimum	Maximum	Mean	Std. Deviation
A	0.3	130	12.096	17.621
H	1.0	7	1.413	0.879
D	1.0	400	24.533	63.561

Because all the NIPFO in the sample belong to a local forest management association, access to technical advice was not considered as a regressor in the empirical model.

With the simplification imposed by the non observability of the choice attributes, the empirical model becomes what is called the multinomial logit.

$$(4)\ P_{ki} = \frac{e^{\beta_i' s_k}}{\sum_{j=1}^{n} e^{\beta_j' s_k}}$$

Results

The maximum likelihood estimates of the empirical model are reported in table 2.

Table 2: Estimated multinomial model for the probability of a forest owner to carry out afforestation projects

Variable	Coefficient	Standard error	t-ratio	p-value
	Characteristics in the numerator of P_1			
Constant	-0.259476	0.243031	-1.068	0.2857
A	0.014343	0.006902	2.078	0.0377
H	-0.170948	0.149382	-1.144	0.2525
D	-0.005319	0.002735	-1.945	0.0518
	Characteristics in the numerator of P_2			
Constant	0.237652	0.336045	0.707	0.4794
A	-0.060826	0.023230	-2.618	0.0088
H	-0.252187	0.234778	-1.074	0.2828
D	-0.013074	0.006405	-2.041	0.0412
	Characteristics in the numerator of P_3			
Constant	-4.504956	0.708189	-6.361	0.0000
A	0.025477	0.013960	1.825	0.0680
H	0.372059	0.251898	1.477	0.1397
D	0.001931	0.003705	0.521	0.6022

Number of observations:	383
Log-likelihood function:	-403.8506
Restricted log likelihood:	-428.5671
Log-likelihood ratio statistic:	49.4330
Degrees of freedom:	9
Significance level:	0.0000

The coefficients of the number of forest holdings per owner are not statistically significant by usual standards. The same happens with the coefficient of the distance, in the case where the forest owner implements individual and grouped projects. In spite of this lack of statistical significance for the number of forest holdings, it is interesting to retain the signs of its coefficients: negative in the case of the probability of individual and grouped projects only and positive in the case of the probability of individual and grouped projects together. One way to interpret these results is as follows:

- in the case of individual projects the dispersion of the forest lands through more than one holding increases the transaction costs and other costs to implement a project, so that the more concentrated the forest lands are the more likely the forest owner is to carry out an individual project;
- the grouped projects are more likely to happen among small owners who rarely have more than one holding;
- the owners who are more likely to implement not only individual projects but also grouped projects are among those who have more than one holding where they can carry these different types of projects.

The coefficients of the size of the forest lands and the distance between the permanent residence and the main forest holding are statistically significant by usual standards, with the exception mentioned before for the distance, in the case of individual and grouped projects together.

The signs of these coefficients are intuitively plausible:

- the size of the forest lands has a positive effect on the probability of individual projects and individual and grouped projects together, and has a negative effect on the probability of grouped projects;

- the distance between the permanent residence and the main forest holding has a negative effect on the probability of individual and grouped projects.

The larger the size of the forest lands, the more likely a owner is to carry out a project on his own. Big owners are more likely to have enough land to make an individual project viable on its own, without having to cope with the transaction costs of setting up a grouped project with their neighbours. For small owners grouped projects are the only alternative to carry out viable projects.

Proximity to the forest holdings increases the probability of both types of projects. This proximity is sometimes associated with a farming activity for which forestry is still a useful complement. In this case and for other kinds of occupations proximity to the forest holdings makes the owner more aware about what can or should be done to improve his forests. Also proximity reduces the travel costs of forest management.

Model evaluation

As shown in table 2, the log-likelihood ratio test statistic has a value which clearly rejects the null hypothesis that all the coefficients except the one on the constant term are equal to zero. So the result of this test shows that the estimated model is better to predict the probability of each type of project than if we had used only information about a "representative" forest owner (Chambers and Foster, 1983). The information about this "representative" forest owner is contained in the value of the coefficient of the constant term. Since the hypothesis that the coefficients of all the other regressors are equal to zero is rejected, this means that specific information on the individual characteristics of each forest owner is relevant to discriminate the probability of choosing among the four alternatives available.

In spite of this result, the set of individual characteristics contained in the data set available for this study is to short to make the model a good predictor of the choice probabilities. In fact if we look at table 3 with the frequencies of actual and predicted outcomes, we can see that the estimated model predicts correctly 47,5 % of the actual outcomes, most of which corresponding to the case of no project. So more factors, besides the size, the number of holdings and the distance, are involved in the decision to carry out a project. We shouldn't forget, however, that maximum likelihood estimation is not a method conceived to maximise the goodness of fit.

Table 3: Frequencies of actual and predicted outcomes

	Predicted				
Actual	0	1	2	3	Total
0	170	8	0	1	179
1	104	12	0	0	116
2	81	0	0	0	81
3	6	1	0	0	7
Total	361	21	0	1	383

Another important test to make about this kind of model has to do with the property of *independence of irrelevant alternatives (IIA)*. This means that in the multinomial logit model the relative probabilities between two alternatives are independent of the remaining alternatives. So adding new alternatives or withdrawing some of the remaining ones does not affect the relative probabilities.

$$(5) \quad P_{ki} \; / \; P_{kj} = \frac{e^{\beta_i' s_k}}{e^{\beta_j' s_k}}$$

One way to check the validity of this property is to carry out a Hausman's test. This test consists in comparing the values $\hat{\beta}$ of the coefficients estimated with the whole sample with the values $\tilde{\beta}$ estimated with a truncated sample resulting from the elimination of the observations corresponding to some of the choices available to the individuals. Under the null hypothesis that the IIA property holds, there will be no significant difference between the two estimates. Therefore, under the null hypothesis, $\tilde{\beta} - \hat{\beta}$ will be a consistent estimator of zero and the statistic

$$(6) \quad S = \left(\tilde{\beta} - \hat{\beta}\right)' \left[Cov(\tilde{\beta}) - Cov(\hat{\beta})\right]^{-1} \left(\tilde{\beta} - \hat{\beta}\right)$$

is asymptotically chi-square with degrees of freedom equal to rank of the estimated covariance matrices of the coefficients.

The truncated sample we used is the one resulting from the elimination of the observations corresponding to choices for grouped projects alone (choice coded with number 2) or together with individual projects (choice coded with number 3). The value of the Hausman's test statistic for this case is 0.31818. So the null hypothesis cannot be rejected at less than 1,5 % significance level.

Conclusions and forest policy implications

Individual characteristics of the NIPFO, in particular the size of their forest lands and the proximity to their forest holdings, proved to be statistically significant variables to predict the probability they have to implement afforestation projects.

Considering the "size effect", in a region of small scale forestry like the one chosen for this study, there is some demand for grouped afforestation forests by small NIPFO, public incentives being a big help to overcome the heavy transaction costs of this kind of operations. NIPFO with larger forest domains are have likely to skip these costs and carry out afforestation projects on their own. So some intensive extension work is needed to help NIPFO of different sizes to cooperate in joint projects able to improve forest management in a wider scale than the one resulting from these more spontaneous choices.

This extension work is also important if we take into account the "distance effect" which reduces the propensity for afforestation projects by NIPFO. Forest extensionists can help to make the connections between local NIPFO interested in grouped afforestation projects and neighbouring NIPFO who live far away from their holdings.

This extension work is an important mission for local forest management associations, like the one created some years ago in the region of this study and in other parts of Northern Portugal where small scale forestry is predominant. Because of the "public goods" nature of most of this work public financial support for these associations is crucial at these early stages of their lives.

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