

THE ECONOMIC VALUE OF RISK REDUCTION OF FOREST FIRES IN SPAIN

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Risk of forest fires has been a subject of study from different disciplines, but its economic valuation has received relatively little attention. This paper discusses the main issues involved from an economic perspective, and presents the results of an application to value the reduction by half of the risk of forest fires in Catalonia. Results and specific risk valuation problems are discussed with some detail.

1. INTRODUCTION

As in most European regions, each year, there are many forest fires in Catalonia. The amount of forests affected varies considerably from year to year. The last large fires in the region happened in 1986, 1994, and 1998. It constitutes one of the problems that consistently more attention have from the media in summer. It also becomes a political issue. Both manifestations reflect a social concern for forest fires. The administration devotes an increasing volume of resources every year to try to diminish the number of hectares devastated by fire. It seems logical to ask the question of whether not enough resources are still devoted to this policy, or conversely whether too much money is invested already. Also, what would be the maximum amount of resources society wish to put into some given reduction of the risk of forest fires?

Those are the questions this paper tries to answer for a given Mediterranean region: Catalonia. The discipline of economics has developed the instruments to assess the social economic value of risk reductions of forest fires. Instruments like the Contingent Valuation Method (CVM), Travel Cost Method (TCM), or Hedonic Price Functions (HP) are the most well known. CVM has been applied to value risk reductions of forest fires in the West coast of the USA (Loomis *et al*, 1996; Loomis and González-Cabán, 1998.)

However, the number of applications is very small, and –to our knowledge- no social valuation exercise has been undertaken in Mediterranean regions. The usual economic figures derived from forest fires reflect the lost value of market goods (timber, cork,...) But they can be far from the actual social loss. Even if the whole loss is estimated, its translation to risk reduction policies is not straightforward. The most sensible approach would seem to be to conduct an *ad hoc* study to obtain such a value. This is the way taken in this paper, using CVM.

The next section summarizes the studies that use CVM for measuring the economic value of reductions of forest fires. The third section presents some data on forests and risk of forest fires in Catalonia, as well as the main policy presently in place. It is followed by a section on the valuation exercise, where the main results are underlined. Finally, some conclusions and further research suggestions are given.

2. LITERATURE REVIEW

One of the first studies on the influence of fire on forest recreation was Vaux *et al.* (1984). Its primary objective was to demonstrate the viability of CVM for valuing such consequences. It involved about 70 students rating photographs of burned and unburned forests and then expressing a willingness to pay for the preferred scene.

Loomis *et al.* (1996) applied CVM to obtain the willingness-to-pay (WTP) for protecting the old-growth forest from catastrophic fires in Oregon. The simulated fire prevention and control program proposed to the respondent would reduce by half (3500 acres) the number of acres of old-growth forest that would burn in Oregon each year. They used a dichotomous choice format followed by an open-ended willingness-to-pay question. The annual value per household in the sample was \$90. In terms of social value per acre of old-growth forest protected from fire, the WTP was \$28.

Following the previous exercise, Loomis and González-Cabán (1998) used CVM to estimate the economic value to California and New England residents of implementing a fire management plan to reduce the number of acres of old growth forests that burn in California and Oregon. The elicitation question had the format of a dichotomous choice. The estimation of the WTP was obtained through a random effects probit model to account for the panel data. The average WTP to reduce catastrophic fire in 2570 acres was of \$56 per household.

3. FORESTS AND RISK OF FIRE

Forestry land accounts for about 62% of the surface of Catalonia. This almost doubles the part of the region devoted to agricultural uses (33%) Although the composition of the forest varies from the coastal areas to the Pyrenees and the inland plains, most of the masses are composed of Mediterranean species. The dominance corresponds to the pine, with 50% of the surface, followed by quercus, with some 40% (Ministerio de Medio Ambiente, 1995.)

Forest fires in the Mediterranean basin have always been a natural factor that constitutes a part of the ecosystem. This has led to the adaptation of some species to fire, like the serotin pines of Mediterranean pinewood (*P.halepensis*, *P.pinea* and *P.pinaster*). Also, it is noticeable the capacity to sprout of several species like holm oaks (*Q. ilex*) or kermes oak (*Q.coccifera*), or the resistance of bark of cork oak (*Q.suber*) to fire.

In this study, the good to be valued was a fire conservation and control program to reduce the fire risk. To estimate the risk of fires in Catalonia, data on hectares burned per year were taken into account from 1983 to 1998. Table 1 shows the basic trend. The mean number of hectares burned in the region each year was about 10 thousand, which represents a 0.75 per cent of the total forest surface of the region.

Table 1. Annual forest surface burned in Catalonia

Years	Hectares Burned
1983	15225
1984	3431
1985	7566
1986	43290
1987	1215
1988	1002
1989	1298
1990	668
1991	3231
1992	757
1993	3328
1994	62575
1995	2202
1996	531
1997	625
1998	14130
Total	161074
Annual Mean (Ha)	10068
% Over Forest Surface	0.75%

Source: DARP (1999)

The mean number of hectares burned each year is of some 10 thousand, or a 0.75% of the forestry area, although with a great deal of dispersion, with about one year per decade of relatively high devastation.

4. VALUATION

4.1 Survey design

The narrative of the proposed program indicated that the program would reduce by half the current annual risk of forest fires in Catalonia and, therefore, the average annual hectares burned (from 10000 to 5000) in Catalonia. The reason for estimating this reduction and not a more drastic one was two-fold. First, a risk reduction to zero hectares

burned per year is not found credible, and probably not even desired. By the main reason was that a 50% risk reduction was in line with the policies discussed at the time.

Before asking respondents whether they would pay for a fire reduction program, they were asked about the relative importance of different forests externalities: recreational use, CO₂ fixation, and erosion reduction. In this way, respondents had in mind some of the main consequences of forest fires for the general public.

The means by which all respondents would pay was framed as voter referendum. All respondent were asked the following question:

Due to forest fires, each year an average of about 10 thousand Ha of forest are burned in Catalonia, which is close to 1% of the whole forest area. Currently, the Administration devotes some 500 pesetas per person and year to preserve and clean the forests. The risk of fires could be reduced by half, and on average some 5000 ha of forests would burn per year. To implement this program some 1500 pesetas per person and year would be required.

Would you pay 1000 pesetas more per year in taxes in order to implement this program that reduces the risk of forest fires by 50%?

The amount of money the administration devotes to forest prevention, including cleaning programs, was established in 500 pesetas per person in round numbers, which translates to 1500 pesetas per hectare, although no direct information was found on the actual expenditure. The approximation was estimated using official data from the regional government (DARP, 1996) and data from facilitated by other centers (Consorci Forestal de Catalunya and Centre de la Propietat Forestal). The estimation of the cost per person of reducing fire risk by 50% was based on expert judgment and the information in *Pla General de Política Forestal* (1994). The new cost per person was established in 1500 pesetas per person and year, which is believed to cover the cost of the required action.

Finally, the last part of the questionnaire included some demographic and socioeconomic questions such as age, education, membership to an environmental organization, or income.

4.2 Survey design

The sample size was of 500 people. Interviews were conducted face-to-face in the household of the selected individuals. To cover the region, the sample was split among the four provinces and to cities of different sizes, according to their actual population. Table 2 shows the areas interviewed, while table 3 represents the distribution of the sample among age and gender.

Table 2. Sample distribution per provinces and municipality sizes

Province	Less than 10000 people	Between 10000 and 100000 people	More than 100000 people	Total
Barcelona	Garriga (10) Centelles (10) Santa Coloma de Cervello (10) Arenys de Munt (10) Alella (10)	Gavà (40) Viladecans (40) St Andreu (40)	Barcelona (130) Cornella (30) St Colona (50)	380 (76%)
Girona	Anglès(10) Bescanó (10)	Girona(15) Banyoles (10)		45 (9%)
Lleida	Torre-serona (10) Mollerussa (10)		Lleida (10)	30 (6%)
Tarragona	Flix (15)	Reus (20)	Tarragona (10)	45 (9%)
Total	105	165	230	500

Table 3. Sample distribution per age and gender

Age	Men	Women	Total
18-29 years-old	50	50	100 (20%)
30-44 years-old	75	75	150 (30%)
45-64 years-old	75	75	150 (30%)
65 years-old and over	50	50	100 (20%)
TOTAL	250 (50%)	250(50%)	500 (100%)

The typical length of the interview was around 10 minutes. It was administered during the second half of 1999.

5. RESULTS

Although the variation of the expected costs is what allows a good estimation of the WTP, special emphasis was placed on the extra cost of 1000 pesetas per person and year (from 500 to 1500), considered to be the most likely cost. Table 4 shows the high percentage of approval (60%) of a scheme that guarantees the reductions by 50% of the risk of fire, at that cost.

Table 4. Answers to the acceptance of a new preservation and forest cleaning program at cost 1000

Answer	%
Yes	60,4%
No	35,4%
Don't know	3,8%
No answer	0,4%
TOTAL	100%

5.1 Median WTP

The estimation of the WTP indicates up to what cost it would be worth implementing a risk reduction program like the one in question. The median of the maximum WTP was calculated through a regression analysis, with the answers to the elicitation question as a dependent variable and the payments asked (BID) as an explanatory variable. The results of it are shown in table 5. It resulted in a median of 1354 pesetas (at values of year 1999) per person and year, to implement a program that would reduce the risk of fire by 50% from its current levels.

Table 5. Results of the fire reduction program

Variable	Coefficient	T-Statistic	Variable mean
Constant	1.000024940	20.394	1
BID	-0.00036954	-8.158	992.27037

To estimate the values within a confidence interval for the median, a Krinsky and Roob (1986) simulation procedure was applied using 1000 repetitions. For a confidence interval of 95%, the estimated true WTP would be between 1230 pesetas and 1513 pesetas.

5.2 Socio-economic variables

The WTP estimation was also calculated using other covariables in the regression, other than the bid. In particular, the age of the respondent (AGE), the size of the municipality of residence (CITY10) below and over 10 thousand people, as a proxy of the urban/rural environment, and a dummy reflecting the affiliation to an environmental organization (ENVORG). Another dummy (REFOR), denoting whether the person interviewed would agree with expanding the total surface of the region devoted to forests, was included. The last independent variable considered in the model was a dummy (FOREST), which took value 1 if the respondent visited a forest in the last 12 months, and zero otherwise. The results of the regression are shown in table 6.

Table 6. Results of the fire reduction program with Socio-economic variables

Variable	Coefficient	T-Statistic	Variable mean
Constant	0.95408719	11.383	
BID	-0.00026133	-5.811	992,27037
AGE	-0.00402635	-3.337	45.827778
CITY10	-0.1555224	-3.769	0.27777778
REFOR	0.28596407	7.181	0.58148148

Of all the variable considered, BID, AGE, CITY10, and REFOR were found significant, and those are the only ones included in the model of table 6. The positive sign of REFOR indicates that people who value positively an increase in forest land use –in spite of the relatively high percentage of it in Catalonia- tend to be willing to pay more for the risk reduction program. On the other hand, the negative sign of AGE suggests that older people are willing to pay less. The dummy variable CITY10 shows a greater propensity to pay for those leaving in more rural environments. The sign of variable BID is negative, as expected, indicating the cost of the program.

With the regression from table 6, the median of the maximum WTP of the sample increased in relation to the previous one. The median person would be willing to pay up to 2221 pesetas per year (in 1999 values) for the mentioned program. Using again Krisky and Roob approach, with 1000 repetitions, to estimate the limit values for a 95% confidence interval, the estimated median WTP of the population would be between 1656 pesetas and 3176 pesetas.

6. CONCLUSIONS

This paper provides a case study of the contingent valuation method for measuring the willingness-to-pay (WTP) values for reducing the risk of fires in Catalonia. The main result is that 60% of people would be willing to pay the estimated extra-cost of 1000 pesetas per person and year of a program to reduce the risk of forest fire by 50%. The median of the individual maximum WTP for such a reduction is of 2221 (1656-3176) pesetas of 1999 values. Therefore, if the extra-cost was up to 1656 pesetas per person and year, it could be said with 95% confidence that it would be worth implementing the scheme for the 50% reduction of risk.

It seems that those living closer to the rural environment and younger people are willing to pay more for this particular environmental good than the rest of the population.

It would be very interesting to compare the CVM results to those obtained through other methods. Also, it would be very useful to test whether values for risk reduction obtained in one Mediterranean region could be transferred to another with some accuracy. A Mediterranean wide project could fulfill this research suggestion.

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