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A Meta-analysis of Forest Management Valuation Programs: What Management Alternatives are Most Preferable?

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Abstract

Forests ecosystems provide a variety of valuable goods and services. This paper presents a meta-analysis of forests studies around the world that have applied the Contingent Valuation Method (CVM) to value different management programs. The dataset covers 24 studies in 13 countries. We estimate the marginal value of each of the main characteristics of the diverse management plans. The main management programs are linked to protection of biodiversity, wildfire risk prevention, increment of non timber forest product uses, and land use restrictions. Our results show that WTP for a forest management program is sensitive to the program's characteristics, being highly valued the management programs linked to fire risk reduction and habitat protection.

Keywords: Meta-analysis, forest, management

1. Introduction

The importance that forests have in the human well being is undeniable. These ecosystems provide us with innumerable goods and services. According to Daily (1997), forests ecosystem services can be defined as the process and condition through the forest and the species that living in, support and satisfy the human life. Forests provide raw materials for food, fuel and shelter. In the forests, ecosystem components such as microorganism, soils and vegetative cover interact to purify air and water, regulate the climate and recycle nutrients and wastes. Without these and many other ecosystem goods and services, life as we know it would not be possible (Krieger, 2001).

These goods and services include recreational opportunities for hiking, biking, and scenic landscapes (direct use values); waste protection watershed services and carbon storage (indirect use values); and the wildlife habitat and diversity (preservation values). Despite the provision of multiple valuable services and theirs importance, the ecosystem forests suffer from importance threats, including fires and deforestation. The Global Forest Resource Assessment 2005 indicate that, on average, 27.7 million hectares of forests and 5.1 million hectares of other wooded land were burned each year since the year 2000, generating nearly 40% of total anthropogenic carbon dioxide (CO_2) (UNEP, 2004). In the US alone, the Forest Service estimates that by 2050 an additional 23 millions acres of private forest lands in net may be lost by house development. This could have important impacts on many ecological values in watersheds, including water quality (Stein, et al. 2005).

Nowadays these threats are increasing. Deforestation and conversion of forests to agricultural land, continues at an alarmingly high rate – about 13 million hectares per year. Net change in forest area in the period 2000–2005 is estimated at -7.3 million

hectares per year (an area about the size of Sierra Leone or Panama) (FAO, 2006). At the same time, there is an increased concern about this issue and its implications. The necessity of knowing which programs are more valuable by the society is crucial in the context of policy making. As such, the objective of this study is to conduct a meta-analysis of different forest valuation studies around the world. The programs analyze cover a wide range of actions, from avoiding fire and house development, to deforestation reduction through the creation of protected areas or the increase in forested surface, among others.

A meta-analysis approach can be defined as the study of studies. It refers to the statistical analysis of a large collection of results from individual studies for the purpose of integrating the findings (Glass et al., 1981). Proponents of meta-analysis maintain that the valuable aspects of narrative reviews can be preserved in meta-analysis, and are in fact extended with quantitative features (Rosenthal and Di Matteo, 2001).

Recent meta-analyses have been conducted in the field of economic valuation of environmental resources, impacts, and services (Brander et al. 2007). A wide amount of studies have focused on valuation of wetlands (Brouwer et al. 1997, Brouwer et al., 1999; Woodward and Wui, 2000; Ghermandi et al. 2007); woodland recreation (Bateman and Jones, 2003, Zandersen and Tol, 2005); endangered species (Loomis and White, 1996) and general outdoor recreation (Smith and Karou, 1990; Walsh et al., 1992, Rosenberger and Loomis, 2000; Shrestha and Loomis, 2001). To our knowledge, this is the first meta-analysis that tries to fit the results of different studies of forest management programs. The time span of analysis contains the last 30 years. The obtained results should be useful for implementing and elaborating the management plans in forest areas according to societal preferences.

This paper is organized as follows: in the next section it contains a literature review describing the meta-analysis framework and applications. It continues with the data description, model specification, results and conclusions.

2. Data description

An intensive search of studies has been conducted in different databases such as ECONLIT, EVRI, AGICONSEARCH and others. Initially, the search resulted in more than 24 studies. However, for some of these studies we could not get information about the surface analyzed and as a result we have to eliminate them from our dataset. Other studies did not contain information about the question format, or the type of the forest analyzed. As a consequence, we could only use data for our meta-analysis from 24 studies, 12 of which are from Europe, 5 from USA and 7 from others countries, including Canada, Australia and Lebanon, among others. From these 24 studies, we were able to include 80 observations, with a mean of 3.2 observations per study. The major number of observations that we took from one study were 19 from Scarpa et al. (2000), while the minimum was one observation from each study.

The studies reported their results in different units (e.g. total value, per hectare, etc.), for different periods (from 1991 to 2007) and in different currencies ($US, SEK, €, etc). In order to homogenize all information, values were transformed to a standard measure, per year or one-time payment, per household or other payer, and in current dollars. We focus on the mean WTP estimates instead of medians.. According with Gürluk (2006), if the decision-maker wishes to make a choice based on efficiency criteria, then the mean is the most appropriate measure (Brent, 1998; Bateman et al, 2002). In the Table 1, we summarize the different studies collected , the number of

observations extracted from each study, the principal format used, and the value of WTP expressed in $US of 2008.

All of these studies use the CVM methodology. Primary, the question format used is the dichotomous format (DC), with 41 observations. Only 12 employed the payment card (PC) and 27 an open ended question (OE). As stated earlier, the welfare estimates were expressed in different currencies and through the $ exchange rate and the consumer prices (index, 2000=100), we update them to a common currency measured in 2008 prices.

3. Model Specification

The dependent variable in our meta-regression equation is a vector of WTP values, labelled as (y). Following Brander et al. (2006), the explanatory variables are grouped into three different matrices that include the study characteristics in X_s, the forests and programs characteristics in X_f, and the site and socio-economic characteristics in X_e. Then, the estimation model corresponds with the following equation:

$$y_{ij} = \alpha + X_{sij}b + X_{fij}b + X_{eij}b + \varepsilon_{ij}, \qquad (1)$$

where α is the usual constant term, the vectors b contain the estimated coefficients associated with the respective explanatory variables, and ε a vector of residuals. Subscript *ij* stands for variable *i* from study *j*. We estimated a classical ordinary least squares (OLS) regression model. Following equation (1), our empirical specification is:

$$\ln(y) = \alpha + \beta_1 annual + \beta_2 household + \beta_3 visitor + \beta_4 dc + \beta_5 oe + \beta_6 talk + \beta_7 write + \beta_8 ahousedevelop + \beta_9 afire + \beta_{10} iprotection + \beta_{11} enlargesize + \beta_{12} mixprogram + \beta_{13} programwooduse + \beta_{14} programbiorecre + \beta_{15} programntfp + \beta_{16} coniferous + \beta_{17} otherf + \beta_{18} oldgrowth + \beta_{19} mainlyuse + \beta_{20} mainlynonuse + \beta_{21} \ln surface + \beta_{22} usa + \beta_{23} eu + \beta_{24} urban + \beta_{25} burned + \beta_{26} \ln gdps + \beta_{27} period1 + \beta_{28} period2 + \varepsilon \quad (2)$$

The dependent variable (y) in our regression equation is a vector of WTP values expressed in 2008 US prices. As mentioned before, we have distinguished between three groups of explicative variables. The first group of explanatory variables is the study´s characteristics, including: the type of payment; annual or one-time is included through the variable *annual*; and the type of respondent, household, visitor or other contributor, who is denoted by the variables *household* and *visitor* and the omitted *otherpayer*. Other included variable is the question format: open ended (*oe*), dichotomous choice (dc), and payment card (*pc*); and the survey mode, including face to face and telephone (*talk*), mail (*write*) and a combination of the previous modes with the omitted variable (*mix*). Other characteristics that may serve as explanatory variables, such as average age, education and household size, were only sporadically reported in the selected publications, so they were not included in the present study.

The second groups of variables are the so-called good characteristics. First we have identified six principal programs, including respectively five explanatory variables in the regression. In the first group, we include the protection plans with mainly directed to avoid the development of houses in the forested area (*ahousedevelop*). The second type contains means of protection against forest fires (*afire*) and prevent that previous fires will occur again. In the third group, we include the programs that provide increments in the protection and conservation through new plans of preservation of the

existent forest (*iprotection*). The fourth type collects the programs that increase the size of the forest through reforestation plans (*enlargesize*), and the last type included in the regression, (*mixprogram*), gathers programs that combine an increment on the protection and size at the same time. The omitted programs are those that do not suppose any change and maintenance the situation (*maintenance*). Next we have considered three variables that gather information about the different aspects of the proposed program. We have differentiated between those that had a biodiversity and recreation components values or uses (*programbiorecre*), those that include wood, dung and residues uses components (*programwooduse*), and those with non timber forests products uses (*programntf*). We also include the type of valued forest. We distinguish between coniferous forests[3] (*coniferous*), old growth forests (*oldgrowth*), other forest, that are those that havedeciduous and perennial trees (*otherf*), and rain forests (*rainforest*) as the omitted variable. Moreover, we have taken into account in our regression if the main values evaluated for the authors were mainly use values (*mainlyuse*), mainly non use values (*mainlynonuse*) and as omitted variable and both values (*usenonuse*). Lastly the valued forest surface was collected through the logarithm of the surface in hectares (*lnsurface*).

Finally, in the third group of site and socio-economic characteristics, we include the indicator variables denoting whether the study was conducted in European countries (*eu*), in USA (*usa*) or in the rest of the world (*rw*) (omitted variable). We also include as explanatory variables the location of the forest, in relation to urban areas (*urban*), and the percentage of the burned forest hectares with respect to the total forest surface in the

[3] We have done the classification in function of the main type of forest valued in the study. In some cases, we have to complete the dataset with information outside the study.

country of the study (*burned*)[4]. Other relevant variable is the logarithm of the gross domestic product per capita at the year of the survey [5](*lngdps*). Finally, and following previous meta-analyses, we include the publication year through three dummy variables: *period1*, before 1995, *period2*, between 1996 and 2000, and *period3* (omitted variable) from 2001 to 2007.

The model fit was considerably improved by using the logarithms of the dependent variable, the GDP per capita and valued forest size. This is also a common feature in previous meta-analysis as Brander et al. (2006) or Brander et al. (2007). The explanatory variables are summarized in Table 2.

4. Researcher hypotheses

The main hypotheses of our study are those that assess the influences of the different management programs in our dependent variable. In particular the hypotheses can be expressed as follows:

$$H_{01} : \beta_8 \leq 0 \quad (3)$$

$$H_{02} : \beta_9 \leq 0 \quad (4)$$

$$H_{03} : \beta_{10} \leq 0 \quad (5)$$

$$H_{04} : \beta_{11} \leq 0 \quad (6)$$

$$H_{05} : \beta_{12} \leq 0 \quad (7)$$

[4] In some case, we have included the average of burned hectares in the country for lack of other information.
[5] In some cases we could not find this data and we used the publication year.

We expect that the coefficients are different from zero and carry a positive sign, in the sense that implementation of a given program has a positive effect in WTP (*lnwtp*). In the first hypothesis (equation 4), we expect that the coefficient of the variable *ahousedevelop* is different from zero and positive, the same results are expected for the coefficients of *afire* (equation 5), *iprotection* (equation 6), *enlargesize* (equation 7) and *mixprogram* (equation 8).

Our last hypotheses are linked to the fact that the coefficient of the variable *mixprogram* is bigger than the coefficients of *iprotection* (equation 8) and *enlargesize* (equation 9)

$$H_{06} : \beta_{12} > \beta_{10} \tag{8}$$

$$H_{07} : \beta_{12} > \beta_{11} \tag{9}$$

The reason is that we assume that the combination of two single programs in one management plan has more influence that each type of program separately.

5. Results

The regression results are displayed in Table 3. These results provide evidence about the types of variables that affect the WTP for the establishment of management programmes in forest areas. The adjusted R^2 is 0.96. In this model, the coefficients measure the constant proportional or relative change in the dependent variable for a given absolute change in the value of explanatory variable. For the logarithmic explanatory variables the coefficients represents elasticities, that is, the percentage

change in the dependent variable given a percentage change in explanatory variables expressed as logarithms (Ghermandi,et al. 2007).

In Table 3 we can observe the positive effect of the different forest programs. Variables *ahousedevelop*, *afire* and *mixprogram*, are statistically significant. Therefore, we can reject the null hypotheses presented in equations 4, 5, and 7. However, for the coefficients *iprotection* and *enlargesize*, we are not able to reject the corresponding null hypotheses. The programs that are a combination of different management plans (*mixprogram*) are more likely to derive in higher WTP estimates, if compared with a single program (*iprotection* or *enlargesize*). As such, we can also reject the eight and nine null hypotheses.

In the group of good characteristics we find that the type of forest is statistically significant. The coniferous forest, old growth forest and other forest (deciduous and perennial) affect less the propensity to pay than the rain forest. On the other hand, if the management program has an emphasis on logging wood, or dung and residues uses (*programwooduse*), the WTP is lower than if the main component is about non-timber forest uses (*programntf*). If the program is based on improvement of biodiversity conditions and recreation uses (*programbiorecre*), it derives in higher WTP values. Lastly, it is worth mentioning that mainly use values have a statistically significant and positive effect on WTP, and it is more likely to derive in higher estimates than a combination of both uses. This result confirms the previously obtained by others meta-analyses, as Ojea (2008).

The model shows that people have significantly higher WTP when stated as a household contribution. Other significant study characteristic is the question format. If the WTP question is via a DC question, the influence is positive and statistically

significant, while OE questions are not statistically significant. The results are as expected and confirm that the findings that the literature suggests in the sense that OE questions provide lower estimates of WTP (Walsh et al., 1992) , while on the other hand, DC often yields higher estimates of WTP (Walsh et al,; 1992; Boyle et al., 1994). In relation with the survey mode, there is a significant and positive effect whether the survey is done via mail . Also, the results show that the talk mode produces higher WTP than others modes. That can be explained through the previous literature that indicates that face to face surveys were seen to overestimate WTP (Leggett et al., 2003).

Finally, the site and socio-economic characteristics show that if the valued forests are in the proximity of an urban area, these are less valued than non-urban forests are. This result confirms others obtained by Lindhjem (2007) for urban forest and by Ojea (2008) for environmental goods near to urban area. The percentage of the burned forest hectares in relation with the total forest in the country is significant and has an positive influence on the WTP to implant a new program. Other results confirming the basic principles of economic theory is the positive and statistically significant influence of the GDP on the WTP, suggesting a slightly elastic effect of income. This result has been also obtained in others meta-analyses as well, such as Brander et al. (2006) and Ghermandi et al. (2007) for wetland. This means that high income countries have a higher WTP than low income ones. Lastly, for the articles published before 1995 the WTP values for forest management plans are larger than those coming from the omitted period. In the following period (from 1996 to 2000) occur the same, but this is not statistically significant. This is an unexpected result, because it is expected that societies increase in environmental consciousness over time.

6. Conclusions

The present study has provided a comprehensive review of CV forest studies and through a meta-regression we contributed to the identification of main determinants of forests ecosystems programs. With these results we can outline some important conclusions. It seems that when the forest is associated mainly with use values its WTP increases. On the other hand, the programs that try to avoid house development and fire effect are also preferable. Moreover, we can observe that the plans that combine two sub-programs are more preferred that a single program. These results can be useful from the perspective of forest management. Forest managers should know that a combination of various aspects like recreation and reforestation will have a positive perception. Also, those programs that have a component which increases the use of non timber forest are perceived in a positive way, while programs that increase the logging use are less desiderable in terms of peoples´ preferences.

The analysis of prevention policies is and important for a good management of a region and its ecosystems. In recent years, the use of meta-regression models based on existing studies to estimate the value of resources at a new policy site has become a popular alternative to collecting original data (Moeltner, et al. 2007). Our final objective is that through this meta-analysis, we can estimate benefit values in other sites when a “first best” empirical non-market valuation study is not feasible, due to limited time or resource using a benefit transfer approach (Shertha and Loomis, 2003).

Annex

Table 1: Studies, mode, observations, method and willingness to pay from each individual study.

Author	Year of publication	Observations	Mode	WTP($US)	Question Format
Amirnejad et al.	2006	1	Face to face	33.58	DC
Broberg	2007	1	Mail	42.88	PC
Gregory	2000	3	Mail	60.29-17.05	DC
Hadker et al.	1997	1	Face to face	0.32	PC
Haefele et al	1991	4	Mail	153.99-27.96	DC-PC
Hung et al.	2007	1	Face to face	8.10	PC
Hutchinson and Chilton	1999	4	Face to face	36.04-69.53	OE
Kniivilä et al.	2002	2	Mail	43.39-53.80	DC
Köhlin	2001	2	Face to face	7.16-16.88	DC-OE
Kramer and Mercer	1997	2	Mail	31.52-46.53	PC-DC
Lehtonen et al.	2003	1	Mail	234.66	DC
Lockwood et al.	1993	3	Mail	61.44-252.72	OE-DC
Loomis et al.	1993	3	Mail	56.49-102.08	OE-DC
Mäntymaa et al.	2002	4	Mail	50.74-86.07	OE
Mill et al	2007	3	Face to face	67.42-191.46	DC
Pouta	2005	2	Mail	93.74-58.23	DC
Reaves et al.	1999	3	Mail	10.56-16.75	OE-PC-DC
Sattout et al.	2007	5	Face to face	21.94-52.28	OE
Scarpa et al.	2000	19	Face to face	2.36-6.05	DC
Shechter et al.	1998	4	Telephone	123.15-162.54	DC-OE
Svedsäter	2000	2	Mail and face to face	70.96-86.66	OE
Tyrväinen	2001	3	Mail	21.62-49.38	PC
Tyrväinen and Väänänen	1998	3	Mail	39.79-65.05	PC
Veisten and Navrud	2006	2	Mail-telephone	5.37-9.07	DC-OE

Table 2: Variable description and Summary Statistics.

Comment: Melina, que significan as estrellas nas variables?

Variable	Description	Mean	Std. Dev.
Lnwtp	Dependent variable. Logarithm of wtp extracted of the original studies per respondents ($US-2008)	3.25762	1.40357
Study characteristics			
annual	=1 if the wtp is per year =0 if the wtp is one-time	0.6625	0.47584
household	= 1if the respondents are household =0 otherwise	0.6875	0.46644
visitor	=1 if the respondents are visitor =0 otherwise	0.275	0.44933
otherpayer+	=1 if the respondents aren't household or visitor =0 otherwise	0.0375	0.19118
dc	=1 if the question format is dichotomous format =0 otherwise	0.5125	0.50300
oe	=1 if the question format is open ended =0 otherwise	0.3375	0.47584
pc+	=1 if the question format is payment card =0 otherwise	0.15	0.3593243
talk	=1 if surveys are conducted in person or telephone =0 otherwise	0.5	0.50315
write	=1if surveys are conducted via email =0 otherwise	0.45	0.50063
mix+	=1 if surveys are conducted through a combination of modes =0 otherwise	0.05	0.21932
Good characteristics			
ahousedevelop	=1 if the program is for avoid house development =0 otherwise	0.075	0.26505
afire	=1 if the program is for avoiding fire =0 otherwise	0.125	0.33281
iprotection	=1 if the program is for increase the protection =0 otherwise	0.375	0.48718
enlargesize	=1 if the program increase the forest area =0 otherwise	0.05	0.21932
mixprogram	=1 if the program combine protection and increase the size =0 otherwise	0.1125	0.31797
maintenance+	=1 if the program maintenance the forest in the same situation =0 otherwise	0.2625	0.4427689
programwooduse	=1 if the program has a component for management the wood. dung and residues uses =0 otherwise	0.1875	0.39277
programbiorecre	=1 if the program has a component of recreation and biodiversity =0 otherwise	0.3625	0.48376
programntfp	=1 if the program has a component for management and benefit =0 otherwise	0.0875	0.28435
coniferous	=1 if the forests are mainly coniferous =0 otherwise	0.3875	0.49025

otherf	=1 if the forests are a combine of deciduous and perennial =0 otherwise	0.275	0.44933
oldgrowth	=1 if the forests are old growth =0 otherwise	0.275	0.44933
rainforest+	=1 if the forests are rainforest =0 otherwise	0.0875	0.2843491
mainlyuse	=1 if the main values are use values =0 otherwise	0.4	0.4929888
mainlynonuse	=1 if the main values are non use values =0 otherwise	0.3375	0.47584
usenonuse+	=1 if the values are use and non use =0 otherwise	0.2625	0.44277
lnsurface	logarithm of the surface evaluate in the study	8.00818	3.51429

Site and socio-economic characteristicsy

usa	=1 if the study is conducted in European countries =0 otherwise	0.175	0.38236
eu	=1 if the study is conducted in USA =0 otherwise	0.575	0.49746
rw+	=1 if the study is not conducted in Europe or USA =0 otherwise	0.25	0.4357447
urban	=1 if the forest are situated in a urban area =0 otherwise	0.0875	0.28435
burned	Percentage of burned forest hectares in relation of total forest surface in the country of the study	0.623988	1.38123
lngdpp	logarithm of the gross domestic product per capita of the year of the survey	9.89174	0.98588
period1	=1 if the study was published before 1995 =0 otherwise	0.125	0.33281
period2	=1 if the study was published between 1995 and 2000 =0 otherwise	0.5375	0.50174
period3+	=1 if the study was published between 2001 and 2007 =0 otherwise	0.3375	0.47584

Note: + omitted variable

Table 3: Meta-regression results:

Dependent variable lnwtp			
Variables	**Coefficients**	**Std. Err.**	**t-value**
annual	1.204564	0.2569347	4.69***
household	1.53606	0.6314921	2.43*
visitor	-0.5104576	0.8110761	-0.63
dc	0.7240536	0.1861955	3.89***
oe	0.0871622	0.2157258	0.4
talk	2.111082	1.311626	1.61
write	1.00899	0.4829631	2.09*
ahousedevelop	5.979826	1.513774	3.95***
afire	2.582403	0.8303504	3.11**
iprotection	0.5799042	0.6027151	0.96
enlargesize	0.9133983	1.266165	0.72
mixprogram	1.730216	0.528223	3.28**
programwooduse	-1.815208	0.2811084	-6.46***
programbiorecre	0.3870609	0.2202664	1.76*
programntfp	1.766139	0.4782503	3.69***
coniferous	-1.428695	0.3100618	-4.61***
otherf	-1.031782	0.3181123	-3.24**
oldgrowth	-1.284068	0.5174881	-2.48*
mainlyuse	0.4268483	0.2304699	1.85*
mainlynonuse	0.1947912	0.2167143	0.9
lnsurface	0.1041598	0.0511204	2.04*
usa	-0.4717321	0.6229826	-0.76
eu	0.9137281	1.245396	0.73
urban	-4.835731	0.9303762	-5.2***
burned	0.2271461	0.1338351	1.7*
lngdps	0.7205665	0.249422	2.89**
period1	1.620354	0.7651371	2.12*
period2	0.2168351	0.2599197	0.83
cons	-9.038053	2.390806	-3.78***
N		80	
Adjusted R^2		0.9684	

(***) indicates statistical significance at α=0.001; (**) indicates statistical significance at α=0.01; and (*) indicates that the variable is statistically significant at α=0.1.

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