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Abstract

The psychological literature has emphasized that choice complexity and other contextual factors affect how people make decisions. However, empirical economic choice models generally do not consider the complexity of different scenarios when estimating preferences from contingent valuation or stated choice models. Recently Swait and Adamowicz (2001b) propose and estimate a conditional logit model that takes into account choice complexity in making inferences from individual data. Choice complexity is modeled as an entropy index that measures how close choice alternatives are in preference space. This definition implies that choice complexity is a function of the same parameters as the utility function and they must be estimated simultaneously. We apply this framework to a stated choice experiment conducted in Chile to value the environmental impacts caused by hydroelectric projects, namely, the destruction of native forests and the relocation of indigenous communities. The survey contains close to 3.000 observations, which makes it an ideal data set to apply the estimation strategy proposed by Swait and Adamowicz (2001b). The results of this paper show that taking into account choice complexity in the modelling of individual decision-making increases the average valuation of the environmental resources under study. This evidence implies that valuation studies based on choice surveys that do not take into account choice complexity may lead to biased results.

1. Introduction

The psychological and behavioral theory literatures have shown that the way choices are framed, the decision environment, the complexity of the choice task and other factors affect how people make choices.[1] This phenomenon could be related to cognitive and information processing limitations of individuals. However, in spite of the growing recognition of this literature by mainstream economists, economic models that use choice data to estimate preferences generally assume that individuals are able to fully understand the alternatives poised to them and make a rational choice among these alternatives. Recently several empirical methodologies have been proposed to model choice complexity and the selection of decision heuristics in individuals' decision problem.[2] The results show that modelling these phenomena are important if correct inferences are to be made regarding consumer behavior and preferences.

In this paper we apply the methodology proposed by Swait and Adamowicz (2001b) to a Stated Choice experiment conducted in Chile in 2002. The objective of the experiment? contracted by the National Energy Commission? was to obtain the marginal social valuation of different environmental and social impacts caused by hydroelectric dams. The impacts for which values were sought included: the flooding of native forest land, the flooding of other types of land and the flooding of land belonging to ethnic indigenous minorities (after they were duly compensated according to existing legislation). The values resulting from the study are currently being used to rank the economic and environmental convenience of the fifty or so hydroelectric projects currently under study in the country.

The Stated Choice experiment consisted of a survey applied to close to 3.000 heads of households nationwide. The survey contained an introduction with pictures and text explaining the objects to be studied, facts concerning electricity generation in Chile, the different types of impacts associated with hydroelectric dams and other relevant information. The payment vehicle used was the monthly electricity bill. After some background questions concerning people's knowledge and attitudes (belong to an environmental organization, number of visits to a national park, number of hydroelectric dams which they are familiar with, etc.) respondents were asked to choose their preferred option among three alternatives in each of three scenarios. For each scenario, the first two alternatives were the construction of different hydroelectric projects varying in size, environmental

[1] See Camerer (1995) for a review of the literature from experimental economics. Se also Thaler (1987).
[2] See Swait and Adamowicz (2001a) and Swait and Adamowicz (2001b).

impacts and the effect on future electricity bills. The third alternative was not to build either of the two projects, but future electricity bills would be correspondingly higher. Thirty such scenarios were constructed using a main effects experimental design and a set of three scenarios were included in each of ten different survey questionnaires.[3]

The scenarios presented to each surveyed individual were therefore different. In some scenarios one of the two hydroelectric projects dominated the other in all dimensions. In other scenarios both projects were fairly similar. Thus it is reasonable to suppose that in some scenarios the choice decision faced by the interviewee was less complex than in others. For example, when one project dominated the other in all dimensions the choice decision should be comparably easier since rational individuals would never pick the dominated alternative. On the other hand, individuals may have problems evaluating the optimal choice when projects are very similar (in preference space). If this is the case, and choice complexity does affect decisions, then not taking this into account may bias the inferences made regarding preference parameters and ultimately the valuation of the environmental impacts.

In order to test this last hypothesis we apply the methodology developed by Swait and Adamowicz (2001b) to the survey data described above. These authors propose a standard Random Utility Model except that the variance of the unobserved preference parameter, or error term, depends on the difficulty of the choice faced by the individual. Choice complexity, in turn, is measured by an entropy measure that summarizes the similarity between choices in preference space. Thus, if choices are very similar, entropy will be higher and individuals may have difficulty in evaluating alternatives.

Basically, the model proposed by Swait and Adamowicz (2001b) to estimate preferences is a heteroscedastic conditional logit model, except that the entropy measure and thus the variance of the error term for each observation depends on the same preference parameters as the systematic part of the utility function. Using maximum likelihood techniques it is possible to estimate all parameters simultaneously.

We apply the above methodology and find that the social valuation of the environmental impacts caused by hydroelectric dams are larger than if choice complexity is not taken into account. Thus

[3] Other interesting aspects of the survey include an initial test on respondents to make sure they understood the issues under study and the graphical information presented in the questionnaire. Several scenarios allowed to test for transitivity of preferences and 'irrationality' (choosing dominated projects). For more on this see Figueroa, Gómez-Lobo, Nuñez and Ruiz-Tagle (2003).

we find positive evidence that valuation studies, especially those based on surveys and hypothetical markets (such as contingent valuation and stated choice techniques) that do not take into account choice complexity may be biased.

In the next section we present the model proposed by Swait and Adamowicz (2001b) to model choice complexity in a tractable manner. Following that, more details are provided on the stated choice experiment that gave rise to the data used in this study. We then present the estimation results and the implications for the valuation of the environmental goods. The last section concludes and further research lines are suggested.

2. Model

Assume that individual *n*'s utility from alternative *i* is given by the following indirect utility function:

$$U_{in} = V_{in} + \varepsilon_{in}$$

where V_{in} is the systematic part of the utility (i.e. which depends on the observable characteristics of the choice *i*) and ε_{in} is the unobservable random component. The probability that *n* chooses the *i*th alternative among *K* choices is:

$$P_{in} = \Pr(V_{in} + \varepsilon_{in} > V_{kn} + \varepsilon_{kn}) \quad \forall \quad k \neq i \, .$$

Assuming an i.i.d. Gumbel distribution with common scale factor for the stochastic elements of the indirect utility function leads to the well known Conditional Logit Model (McFadden, 1974). Using this model it is possible to estimate the parameters of the systematic component of the utility function. Based on these estimates the values for the different choice characteristics (which in the context of our study correspond to environmental impacts) can be derived.

Following Swait and Adamowicz (2001b) we model choice complexity by assuming that the stochastic elements of the indirect utility function are independent but not identically distributed. In particular, the error terms are distributed as Gumbel but with a scale factor $\mu_n(C_n)$, which is a function of the complexity of the choice faced by individual n, C_n. The density function of the distribution is:[4]

$$f(\varepsilon_{in}) = e^{-e^{-\mu_n(C_n)\varepsilon_{in}}}$$

with a variance term equal to $\sigma_{in}^2 = \pi^2 \big/ 6\mu_n^2$.

This scale factor is inversely related to the variance of the choice utility among individuals; the smaller the scale factor, the higher is the variance and consequently choices will seem more random. The above assumption leads to the following model (see Swait and Adamowicz (2001b) for details):

$$P_{in} = \frac{e^{\mu_n(C_n|\theta)V_{in}(X_{in}|\beta)}}{\sum_k e^{\mu_n(C_n|\theta)V_{kn}(X_{kn}|\beta)}} \qquad (1)$$

where θ and ß are parameter vectors. To estimate the model the variables of each observation must first be multiplied by the scale factor and the model then collapses to the traditional Conditional Logit Model.

The complexity of a given choice scenario is modeled as an entropy measure of the available k alternatives:

$$C_n = -\sum_{i=1}^{K} Q_{in} \ln Q_{in} \qquad (2)$$

where

$$Q_{in} = \frac{e^{V_{in}(X_{in}|\beta)}}{\sum_k e^{V_{kn}(X_{kn}|\beta)}} \qquad (3)$$

[4] See Ben-Akiva and Lerman (1985).

the probability of choosing alternative *i* among the *K* alternatives of the choice scenario.

Two features to note regarding this entropy measure is that it is highest when the *Q's* of each alternative are similar. Since *Q* is the probability of an individual choosing that alternative, entropy will be highest when choices are very similar in preference space. This is supposed to represent a difficult decision for individuals since they are unable to distinguish their preferred choice between alternatives. Second, the *Q*'s depend on the parameters of the indirect utility function and the characteristics of the alternatives. This implies that the entropy measure cannot be estimated independently of preference parameters. Thus all the parameters of model (1) must be estimated simultaneously.

This way of measuring choice complexity has several advantages. First, it depends on individual preferences rather than an arbitrary measure of the similarity between alternatives? as would be the case if similarity between alternatives were measured by the weighted difference between the vector of characteristics of each alternative. Second, choice complexity increases as the number of alternatives in a decision scenario, *K*, increase. Third, as noted above, for a given number of alternatives, entropy will be highest when alternatives are very similar in preference space.

Note also that since the characteristics of the alternatives affect the indirect utility function directly and indirectly through the entropy measure, the elasticity of the probability of choosing an alternative to a change in a characteristic is more complex than in the conventional conditional logit model. For example, a rise in the price of one alternative will have a direct negative impact on the probability of the individual choosing that alternative and an indirect impact through its effect on the entropy measure and thus on the variance of the choice scenario.

The final modeling issue that must be resolved is the relationship between entropy and the scale factor µ. Swait and Adamowicz (2001b) assume the following parametric relationship:

$$?(C_n) ? e^{?\,?_1 C_n ? ?_2 C_n^2 \,?}. \quad (4)$$

The estimated values for $?_1$ and $?_2$ determine how complexity affects the variance of the choice scenario. If $?_1 < 0$ then as choice complexity increases, the variance of the choice increases and more randomness in choice will be observed.[5] The second term is included to capture any non-linear effects of complexity of choice variance. In this model, complexity affects behavior by making choices more random and less dependent on observable characteristics of alternatives.

4. The data[6]

The data comes from a Stated Choice (or Stated Preference) experiment undertaken in 2002 on behalf of the Chilean National Energy Commission. This methodology was chosen because the aim of the study was to value environmental impacts of hydroelectric projects in order to rank the set of projects currently under consideration in the country. Since there are over 50 such projects, a contingent valuation approach would have required at least 50 surveys to be undertaken, one for each project. The advantage of the Stated Choice methodology is that valuations for generic attributes of projects can be obtained. These valuations can then be used to estimate the environmental cost of all current and future projects.

The Stated Choice methodology is based on a questionnaire where interviewees are presented with a set of hypothetical scenarios.[7] For each scenario, individuals must choose their preferred option among a set of alternatives. Each alternative has different levels of a given set of attributes (characteristics). Thus, by analyzing the choices made by individuals, the implicit valuation for each attribute can be established. As mentioned earlier, the main advantage of this methodology is that values are obtained for attributes, not specific environmental goods. Marginal attribute valuations can then be used to value a complete set of goods characterized by different levels of these attributes. There is evidence that the stated choice methodology also reduces the 'Part-Whole bias' relative to contingent valuation studies (Foster and Mourato, 1999) and that the results using this methodology are just as good or better than using contingent valuation (Adamowicz, Boxall, Williams y Louviere, 1998).

The stated choice experiment we use was applied nationwide between September 5th and October 8th 2002. It was based on a stratified sampling technique in order to have sufficient statistical representation at the rural as well as the urban level. In the end, 2,992 households were successfully

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[5] The variance term is inversely proportional to the scale factor. Note that the effect in the data will be that different individuals will choose different options as the variance term increases despite the fact that they all have the same systematic utility function.

[6] More details of the survey and its results can be found in Figueroa, Gómez-Lobo, Nuñez and Ruiz-Tagle (2003).

[7] See Louviere, Hensher y Swait (2002) and Bateman, et al. (2002).

interviewed. At the household level, the person interviewed was the member who pays the household's electricity bill, who in most cases coincided with the head of household. Since the interest of the study was to obtain the valuation for all individuals nationally, given the public-good nature of the environmental goods considered, the survey questionnaire explicitly asks the interviewee to consider the collective valuation of all household members in his answers. Naturally, it would have been optimal to interview every household member instead, but this was impossible due to budgetary restrictions and technical reasons.[8] Other studies have used the approach taken here of asking one interviewee to consider the collective valuation of the household for a particular good. The evidence seems to suggest that this approach underestimates the aggregate household valuation (see McFadden (1994)).

The impacts for which valuations were sought included the flooding of native forest land, the flooding of other types of land (non-native forest) and the number of ethnic (indigenous) families living in the flood area or the immediate vicinity of a proposed hydroelectric project.[9] [10] Chilean law obliges the owner of a project to compensate (generally in the form of equivalent land) indigenous families displaced by a project. However, it may be the case that individuals place a value on the impact caused on these families in spite of the compensation required by law. Perhaps they value that indigenous people may live in their original ancestral lands, where cemeteries and other cultural landmarks are located and which cannot be moved. Alternatively, people may perceive that the land offered in compensation may not be of the same quality as the land being flooded.[11]

The payment vehicle chosen in the survey was the monthly electricity bill. Since electricity coverage is practically universal in Chile, every household receives a bill based on measured consumption. Both the focus groups undertaken prior to the survey application and the two pre-test

[8] Since the payment vehicle was the electricity bill, it may not be appropriate to interview household members that do not pay this bill.

[9] To be precise, the area of influence of each project included a small band around the flooding area. Thus, the impact of a project was slightly larger than the land flooded. Thus in the case of hydro projects without dams (flow-through generation) there could still be a small impact to forest areas corresponding to the scenic and environmental impact of the infrastructure (mainly the tubes to convey the water to the generators).

[10] Originally, two types of native forest were thought to be valued: ecologically rich and degraded. However, the pilot study showed that this distinction was not easily understood by respondents and the decision was made to integrate both types into a single category.

[11] The motivation for including in the survey the valuation people have regarding indigenous families stems from the controversy that has engulfed the latest large-scale hydroelectric project under construction in Chile: Ralco in the Bio-Bio river. In this case several Pehuenche families have refused to leave the flooding area. The domestic and international consequences of the debate has highlighted the need to consider this issue in the future development of the electricity sector.

surveys showed that individuals had a very clear understanding regarding the relationship between hydroelectric projects, electricity generation and their electricity bill. They recognized that a trade-off exists between conserving forest land by limiting hydro development and the price of electricity. Therefore, there was ample evidence regarding the credibility of the payment mechanism.[12]

For each attribute or impact a range of physical values were chosen in reference to the range of impacts implicit in the set of future hydroelectric projects currently under consideration according to the National Energy Commission. For each impact a low value, middle value and high value were chosen. For the impacts on electricity bills, six levels were chosen. Table 1 shows the range of values for each attribute.

Table 1: Values for each attribute

Attribute	Unit	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Native forest land flooded	Hectares	200	1,000	5,000	---	---	---
Other type of land flooded	Hectares	1,000	5,000	15,000	---	---	---
Ethnic families affected	Number	0	20	50	---	---	---
Increases in monthly electricity bill	Chilean pesos	0	100	300	500	1,000	2,000

Note: the average household monthly electricity bill was $12,100 among surveyed households who showed their bill. Therefore the maximum rise in the electricity bill corresponds to less than 20% of average bills. At the time of the survey the exchange rate was Ch$727 per US$.

Using the above values, scenarios were constructed in the following way. Each scenario contained two projects, each with a set of attribute levels that included an impact on future monthly electricity bills. Surveyed individuals had to choose one of the two projects as their preferred option for future development, or a third outside option where neither of the two projects are built in the future but the monthly electricity bill rises by Ch$4,000 indefinitely. A main-effects factorial experimental design was used to obtain 26 orthogonal scenarios using the values of Table 1. Four additional scenarios were created in order to test for transitivity of preferences as will be explained further below. In some scenarios the main effects design resulted in one of the two projects totally dominating the other project. That is, all negative attributes (environmental impacts) were lower

[12] There is however one subtlety; households in the two northern regions of the country are supplied from an electricity system where hydro generation is not feasible due to the lack of water sources. For this groups the payment vehicle may not be credible. However, households in these regions represent a small proportion of the national population.

and the impact on the electricity bill was also lower. If the individual is rational, and assuming environmental impacts are 'bads', he should never choose a dominated project. Thus, these scenarios permit to test whether respondents understand the decision poised to them and are able to make a rational choice among alternatives.

Each survey questionnaire contains 3 scenarios. Thus, 10 different questionnaires had to be constructed in order to complete the 30 scenarios. The three scenarios included in some questionnaires had the property that they could be used to test transitivity. By construction, in these questionnaires the first scenario presented, say, project A along with project B, in the second scenario project B was presented with a project C, and in the final scenario project A was presented along with project C. The outside option presents some complications, but with this structure transitivity could be tested.

The survey questionnaire included an introductory section with photographs and text with information regarding the electricity sector, the different forms of electricity generation and the potential impacts caused by hydroelectric dams. After several focus groups and pre-test trials, a graphical representation of project size and attribute levels was established. Another section of the questionnaire explains how project attributes are presented and several questions test the comprehension of interviewees in this respect. Questions regarding the household's electricity bill, attitudes, and socioeconomic characteristics are also included. The main section of the questionnaire presents the three scenarios in turn and the interviewee must choose his preferred option.

Information regarding the results for the survey can be found in Figueroa, et al (2003). For the purposes of the present paper we present the results of the transitivity test and the rationality test based on the choice of dominated projects. Of the 3,792 times it was possible to evaluate rationality in this respect, 1,034 times the respondent chose a dominated project. This corresponds to 27.3% of answers. Thus there is evidence to suggest that in close to 30% of cases, respondents were not being rational. This could be due to lack of comprehension of the scenarios, or lack of effort in analysing and evaluating the options presented in each scenario.

It was also possible to test transitivity in the case of 1,038 households.[13] Of these only 62 answers were inconsistent with transitivity of preferences. Thus only 6.0% of respondents did not meet this

[13] Out of the 10 questionnaires, 4 contained a set of scenarios which allowed transitivity to be tested.

criteria. It is curious that individuals had more difficulty in identifying dominated projects than in avoiding non-transitive responses.

5. Estimation and results

We assume that the utility of project *i* for individual *n* is given by:

$$U_{in} = \alpha_n + \sum_{j=1}^{6} \beta_{1j} \cdot (Y_j - P_i) \cdot I_{jn} + \beta_2 \cdot F_i + \beta_3 \cdot FO_i + \beta_4 \cdot IN_i + \varepsilon_{in} \qquad (5)$$

where Y_c is the average monthly income in one of six income ranges[14], P_i is the impact on the monthly electricity bill of alternative *i* and I_{jn} is an indicator function that takes a value of one if household *n*'s income is in category *j*. This way of modeling income effects was chosen in order to pick up decreasing marginal utility of income across households.[15] F_i is the amount of native forest land flooded by project *i*, FO_i is the amount of other (agricultural, forest plantation, residential, etc.) land flooded by project *i*, and IN_i is the number of indigenous families that are affected by project *i*.

Since choice only depends on the systematic and random differences of utility across alternatives, the above model could just be specified as:

$$U_{in} = \alpha_n + \sum_{j=1}^{6} \beta_{1j} \cdot P_i \cdot I_{jn} + \beta_2 \cdot F_i + \beta_3 \cdot FO_i + \beta_4 \cdot IN_i + \varepsilon_{in}. \qquad (6)$$

In this last specification the household specific constant term, a_n, is not identified as it will cancel out as alternatives are compared.

Although we estimate several models regarding the relationship between choice complexity (measured by the entropy measure) and the scale factor, they are all a nested version of the following general relationship:

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[14] In the original data there are 9 income categories. However, less than 5% of households interviewed were in the last four income groups and thus they were aggregated in order to avoid numerical problems in the estimation due to insufficient observations in the higher income groups.

[15] Household's valuation of an environmental impact will differ according to their income group. Allowing this flexibility is important for valuation studies, especially in developing countries where lower income households may have very different attitudes and preferences to environmental degradation than richer households.

$$? (C_n) \ ? \ \exp ? ?_1 ?C_n \ ? \ ?_2 ?C_n^2 \ ? \ ?_3 ?D_{trans} \ ? \ ?_4 ?D_{dom} ? \qquad (7)$$

where D_{trans} is a dummy variable that takes a value of one if the individual faces a questionnaire with transitive scenarios. D_{dom} is a dummy variable that takes a value of one if the individual faces a scenario with a dominated alternative. These dummy variables are supposed to capture the simplicity or additional difficulty in making a choice when scenarios have the stated characteristics. We hypothesize that the parameter on the D_{dom} variable will be positive, since the presence of a dominated project should make choice easier and thus reduce the observed variance of choice. We do not have a prior belief on the sign of the coefficient on D_{trans} except perhaps that it should not be significant since facing a transitive trio should not by itself make choices easier or more difficult. Complexity should just depend on the characteristics of the projects in each scenario.

Table 2 shows the estimation results. The first column presents parameter estimates using the conventional Conditional Logit command in Stata.[16] The next column presents a model estimated using the entropy measures in the scale factor in a linear specification. Model 3 uses an additional variable indicating whether the scenario has a dominated project. Model 4 includes a variable that indicates whether the questionnaire had scenarios capable of testing for transitivity. A model with the square of the entropy measure in the scale factor had numerical problems and did not converge, therefore the full specification of equation (7) could not be successfully estimated.

Table 2: Estimation Results

Coefficient	Model 1	Model 2	Model 3	Model 4
Price * Income 1	-100.00***	-83.40***	-76.22***	-82.87***
Price * Income 2	-88.91***	-73.17***	-66.40***	-71.15***
Price * Income 3	-65.96***	-52.55***	-48.21***	-51.38***
Price * Income 4	-84.51***	-68.99***	-62.87***	-66.09***
Price * Income 5	-73.84***	-59.92***	-54.82***	-58.29***
Price * Income 6	-27.97***	-21.08***	-18.84***	-18.48***
Native Forest	-8.55***	-8.06***	-7.09***	-6.97***
Other Land	-2.25***	-2.25***	-1.82***	-1.86***
Indigenous families	-1,712.10***	-1,906.83***	-1,777.31***	-1,873.48***
Entropy	---	45,744***	46,938***	48,954***
Dominated project	---	---	18,877***	17,037***

[16] All estimations were undertaken using Stata 6.0. Maximum likelihood programs are available from the authors upon request.

Transitive Scenario	---	---	---	19,066***
Log Likelihood	-7287.4	-7248.9	-7238.7	-7229.7
Number of observations	26,163	26,163	26,163	26,163

Note: all models were estimated using survey expansion factors as weights. *** indicates that the coefficient is statistically significant at the 1% level. COEFFICIENTS ARE EXPRESED AS RELATIVE VALUES TO THE FIRST COEFFICIENT OF MODEL 1. THIS WAS DONE IN ORDER TO AVOID SHOWING THE MONETARY VALUATION OF ENVIRONMENTAL BENEFITS. AS TO DATE THE NATIONAL ENERGY COMMISSION HAS NOT AUTHORIZED THE DISSEMINATION OF MONETARY RESULTS.

All parameter estimates of the indirect utility function have the expected sign and are highly significant. It is interesting to note that with the exception of group 3 the marginal utility of income is decreasing with income as expected. Also in all models the valuation of native forest land flooded is significantly higher than other types of land.[17]

The entropy measure in the scale factor is statistically significant (model 2). It is interesting to note that controlling for choice complexity in this manner hardly changes the coefficients of the environmental impact variables but significantly affects the marginal utility of income estimates. However, the sign of the coefficient associated with the entropy measure is somewhat unexpected. Swait and Adamowicz (2001b) applied there methodology to 10 different data sets. In two data sets the entropy measures were not significant. Of the eight studies where these variables were significant, in four the relationship was concave. That is, as entropy increases the variance of the model increases but passed a certain point it starts decreasing. The intuition for this result is that as complexity increases choice becomes more difficult and so the variance factor also increases. However, when entropy is very high choices are almost identical and so “in these seemingly complex cases, the increased variance arising from increased complexity will be offset by the fact that the utilities are all actually similar, thereby lowering the utility error variance”.[18] In our model, however, no such concave relationship was found since the model with a quadratic term in entropy did not converge numerically. The sign of the linear entropy term implies that as entropy increases the variance of the utilities actually decreases.[19] This also occurred in the four other data sets estimated by Swait and Adamowicz (2001b) and they rationalize this result by stating that “this may

[17] A comparison with the valuation of the impact on indigenous families cannot be made since they are in different units.
[18] Swait and Adamowicz (2001b).
[19] It must be borne in mind that the scale factor and the variance term are inversely related.

have occurred because of limited complexity ranges in those studies, covering only moderate and high complexity decisions but not low complexity scenarios".

This last explanation could also apply in the present study. Given the characteristics and complexity of the contingent choice experiment undertaken in Chile, it is likely that all scenarios presented choice difficulties for interviewees. Thus low entropy scenarios were not present, except perhaps when a dominated option was included in the scenario. Model 3 presents the results if an indicator of dominated project was present in the scenario and the results indicate that it lowers the variance term. This is consistent with prior expectations. For those scenarios with a dominated option, choice is easier and lowers observed choice variance.

The inclusion of a variable indicating that the scenario had a transitive structure is also statistically significant (model 4) and does not substantially change the value of the other coefficients. The sign of this variable implies that the variance term is higher for those four questionnaires compared to the other six. Whether this is due to an intrinsic difference in the project characteristics of the questionnaires or whether it is due to the transitive nature of the scenarios is something we have left now for further research.

The important result for the objective of this paper is that controlling for choice complexity in the manner we have done, does change parameter estimates and will have an effect on the valuation of environmental impacts.

From the parameter estimates of Table 2 it is possible to calculate an average valuation for each of the environmental impacts. The valuation is the amount of monthly income that if taken away from an average individual will leave him indifferent to sustaining the environmental impact. More formally, willingness to pay for the average individual to avoid a small increase in the impact on native forest, WTP_F, is given by the following formula:

$$?_n ? ?_{1n} ??P_{ie} ? WTP_F ?? ?_2 ?F ? ?_3 ?FO ? ?_4 ?IN ?$$
$$?_n ? ?_{1n} ?P_{ie} ? ?_2 ??F ? ?F ?? ?_3 ?FO ? ?_4 ?IN$$

or

$$\frac{WTP_F}{?F} ? \frac{?_2}{??_{in}} \qquad (8)$$

where a_{1n} is the parameter of the income effect in the income category relevant to household n. Valuation for the other impacts are derived in analogous form by replacing the coefficient in the numerator by the appropriate coefficient related to that impact in the indirect utility function.

Table 3 presents the average valuation of each impact according to income group relative to the valuation . For example, the average family in the highest income group is willing to pay 3.58 times more for each hectare of native forest land that is not flooded compared to the lowest income group according to Model 1. As expected, the value of flooding non-native forest land is much lower, close to one fourth the value for native forests. For indigenous families affected the values are higher but it must be remembered that the scales are different (only a maximum of 50 families are affected by a project, while the number of hectares flooded is several orders of magnitude higher). Consistent with the decreasing marginal utility of income, these valuations decrease as the household are in a higher income category.

	Model 1	Model 2	Model 3	Model 4
Native Forest (income group 1, model 1 =100)				
income group 1	100.0	113.1	108.8	98.4
income group 2	112.5	128.9	124.9	114.6
income group 3	151.6	179.5	172.1	158.7
income group 4	118.3	136.7	131.9	123.4
income group 5	135.4	157.4	151.3	139.9
income group 6	357.5	447.5	440.2	441.1
Other land (income group 1, model 1 =100)				
income group 1	26.4	31.6	28.0	26.2
income group 2	29.6	36.0	32.1	30.5
income group 3	40.0	50.2	44.2	42.2
income group 4	31.2	38.2	33.9	32.8
income group 5	35.7	44.0	38.9	37.2
income group 6	94.2	125.1	113.1	117.5
Indigenous families (income group 1, model 1 =100))				
income group 1	20,025	26,743	27,275	26,443
income group 2	22,523	30,481	31,308	30,799
income group 3	30,362	42,445	43,124	42,653
income group 4	23,695	32,326	33,063	33,157
income group 5	27,119	37,218	37,920	37,593
income group 6	71,599	105,822	110,313	118,576

Table 3: Average household valuation for each impact according to income group

Table 4 presents the same information as Table 3 but showing the average valuation for each income category as a percentage of the valuation for the basic model where choice complexity is not modeled. It can be seen that on average the valuation of native forest land flooded is between

6% and 17% higher when choice complexity is taken into account, depending on the model chosen. For other types of land the average valuation increases between 7% to 24% and for indigenous families between 38% and 42%.

It is interesting to note that except for Indigenous families, the values in Model 4 are quite close to those of Model 1. Thus, for the social valuation of native forest land and other types of land flooded, taking into account choice complexity in the estimation strategy does not make a significant difference in the final results. However, for the impact on native indigenous minorities the effect is significant.

		Model 1	Model 2	Model 3	Model 4
Native Forest (values for Model 1 = 100)					
	income group 1	100.0	113.1	108.8	98.4
	income group 2	100.0	114.6	111.1	101.9
	income group 3	100.0	118.4	113.5	104.7
	income group 4	100.0	115.5	111.5	104.3
	income group 5	100.0	116.2	111.7	103.3
	income group 6	100.0	125.2	123.1	123.4
		Average	117.2	113.3	106.0
Other land (values for Model 1 = 100)					
	income group 1	100.0	119.9	106.1	99.4
	income group 2	100.0	121.5	108.3	102.9
	income group 3	100.0	125.5	110.7	105.7
	income group 4	100.0	122.5	108.7	105.3
	income group 5	100.0	123.2	108.9	104.3
	income group 6	100.0	132.7	120.0	124.6
		Average	124.2	110.5	107.0
Indigenous families (values for Model 1 = 100)					
	income group 1	100.0	133.5	136.2	132.0
	income group 2	100.0	135.3	139.0	136.7
	income group 3	100.0	139.8	142.0	140.5
	income group 4	100.0	136.4	139.5	139.9
	income group 5	100.0	137.2	139.8	138.6
	income group 6	100.0	147.8	154.1	165.6
		Average	138.4	141.8	142.2

Table 4: Average valuation increase due to choice complexity

6. Conclusions

Using the data from a stated choice experiment in Chile we find that the hypothesis that choice behavior is not influenced by choice complexity is amply rejected. The results also show that not taking this effect into account may reduce the estimated value of the environmental impacts under study. In the study, the economic valuation was sought for three types of impacts associated with hydroelectric generation: the flooding of native forest land, the flooding of other types of land and the impact on indigenous population. We find that taking into account the choice complexity of the decision faced by the survey interviewee increases the average valuation of these impacts by 6%, 7% and 42%, respectively. Thus, the results of this paper would seem to indicate that choice complexity might be important in inferring valuation for at least some environmental goods.

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