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Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments versus Contingent Valuation

Wiktor Adamowicz, Peter Boxall, Michael Williams and Jordan Louviere

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Department of Rural Economy
Faculty of Agriculture, Forestry,
And Home Economics
University of Alberta
Edmonton, Canada

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Wiktor Adamowicz
Department of Rural Economy
University of Alberta

Peter Boxall
Canadian Forest Service
Northern Forestry Centre

Michael Williams
Intelligent Marketing Systems

Jordan Louviere
Department of Marketing
University of Sydney

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Introduction

The measurement of passive use values has become an important element of environmental economics over the past decade. Damage assessment cases in the U.S. and Canada have prompted considerable research activity in this area, yet the topic is quite controversial and debate over the theory and measurement of passive use values has permeated the economics profession (eg. Hanemann, 1994; Diamond and Hausman, 1994). Much of the controversy surrounds the use of the contingent valuation method (CV) in eliciting passive use values and the various "issues" that arise when this technique is employed. There is a substantial literature on the CV method (eg. Mitchell and Carson, 1989; Natural Resource Damage Assessment, 1994) and its advantages and disadvantages. We do not review this literature here, rather we explore the use of another stated preference approach for measuring passive use values, the choice experiment, and compare it to CV.

Choice experiments have been employed in the marketing, transportation and psychology literature for some time (Batsell and Louviere, 1991; Louviere, 1988a; 1988b, 1991; Hensher, 1994). They arose from conjoint analysis which is commonly used in marketing and has been applied to natural resource damage assessment. Choice experiments (at times called stated preference methods), however, differ from typical conjoint methods in that individuals are asked to **choose** from alternative bundles of attributes instead of ranking or rating them. Thus choice experiments are consistent with random utility theory and are an alternative to CV as a method of eliciting passive use values.

Researchers have achieved positive results using choice experiments to value the effect of environmental improvements on use values (Adamowicz et al, 1994). In this paper we outline the use of choice experiments (CE) for measuring **passive** use values and present several potential advantages of this approach. We then develop a particular empirical application, the measurement of value associated with enhancing the population of a threatened species, using both CV and CE methods of valuation. We also combine the information from both techniques in order to test for differences in preferences and error variances arising from the two methods. Our results show that choice experiments have considerable merit in measuring passive use values for the following reasons: (1) the method provided a richer description of the attribute tradeoffs that individuals are willing to make, (2) the CV model error variance was not significantly different than the error variance in the choice experiment model, (3) when combined with CV data we found that the marginal utility of income parameters were not significantly different (when variance heterogeneity is taken into account), and (4) the welfare values from the CE generally have smaller variances (relative to their means) than the CV estimates. These results lead us to suggest that choice experiments may outperform CV methods in applied analysis.

Choice Experiments

The appeal of CE in economic analysis is that it is based on random utility theory (see McFadden, 1974; Ben-Akiva and Lerman, 1985). In contrast to CV, which asks people to choose between a base case and a specific alternative, CE ask people to choose between cases that are described by **attributes**. These combinations of attributes make up specific situations that are selected from the universe of possible situations (Adamowicz, et al, 1995). Thus, CE involve considerable effort in design, both in the development of the relevant scenarios with appropriate attributes, and in the use of statistical design methods.

There appear to be several advantages to the CE approach relative to CV. First, because CE are based on attributes they allow the researcher to "value" attributes as well as situational changes. Furthermore, in the case of damage to a particular attribute, compensating amounts of other goods (rather than compensating variation based on money) can be calculated. This use of compensating "goods" has been suggested in the Natural Resource Damage Assessment debate as a method of avoiding controversy over funding issues as well as a mechanism for disbursing damage compensation funds (Jones and Pease, 1995; Mazzotta et al, 1994). In order to measure the type or amount of other "goods" that are required for compensation, an attribute based approach is necessary.

A second advantage associated with CE is that their use may decrease concerns over phenomena such as strategic behaviour and "yea-saying." Since respondents are being asked to choose from various scenarios, it may be difficult for them to behave strategically. Yea-saying is said to arise when respondents are placed in a moral dilemma when forced to choose between paying for an environmental improvement and not paying for the status quo. CE avoid these issues since attribute levels change over the sets of choices and it will not be clear which choice is the "environmentally friendly" alternative.

Finally, the issue of embedding (Kahnemann and Knetsch, 1992) or scoping and sequencing (Carson and Mitchell, 1995) has dominated the recent debate over CV. Choice experiments are based on attributes and essentially incorporate different subsets of goods within their design. Thus, embedding is designed in the experiments and the results reveal if individuals are sensitive to attribute levels or not.

Various references on CV suggest that willingness to pay questions (WTP) are preferred over willingness to accept questions (WTA) and that the referendum format is most desirable (eg. Arrow, et al, 1993). The avoidance of WTA questions, however, has been questioned by several authors (eg. Kahneman and Knetsch, 1992). One approach successful in eliciting WTA values is the paired comparison approach (Peterson, et al. 1995). CE follow an “n-tuple comparison” method in which one option is paired comparison. Thus, they may have the advantage of being able to successfully elicit WTA values as well.

Given the potential advantages of CE, their application in measuring passive use values is clearly of interest. However, the design aspects of CE may also create some difficulties. The experiments typically involve main effects statistical designs, thus the attribute effects are limited in the way they can enter the utility function. Also, issues of information provision, survey design, and survey administration are as important in CE as they are in CV. However, there are few examples of the use of CE in measuring environmental values (Adamowicz, et al 1994) and fewer, if any, that assess passive use values. Below we report on a study that uses both CE and CV approaches in a comparative manner to measure passive use values for a woodland caribou management program in Alberta, Canada.

A Woodland Caribou Habitat Enhancement Program: A Case Study

Mountain dwelling woodland caribou rely on the old growth forests in west central Alberta. The area is also characterized by considerable industrial (forestry, oil and gas) and recreational activity. Woodland caribou are listed as “threatened” by the Wildlife Act of Alberta and considerable effort has been placed into programs to maintain and enhance caribou habitat and populations. In Alberta, lands allocated under forest management agreements (FMAs) contain superior woodland caribou habitat. In order to establish protected areas and conditions that biologists consider to be optimal for caribou preservation, holders of FMAs may have to be compensated and recreational uses of the land may be restricted. These issues form the basis for our valuation exercise. A CV question was constructed by describing a change from current management in the region to a scenario that constructs an old growth forest / woodland caribou preservation program. The CE was constructed from the attributes of the situation (caribou populations, wilderness area, employment, taxes paid per household, etc.) and individuals were asked to choose between the current situation (as described by current levels of the attributes) and two alternative "futures."

The old growth forest program used in the CV question involved removal of lands from forestry activity and the creation of a wilderness area. This program also required that recreational activities be restricted in the area (no hunting, fishing or off-road vehicles). The number of caribou in the region was predicted to increase from the current level (400) to a level that biologists consider "a viable population" (600). Thus, the program involved some changes that were hypothesized to be attractive to respondents (caribou population and wilderness area increases) and some that were likely to be unattractive (recreation restrictions and employment effects). The scenario was presented using text, maps, and graphics in a self administered questionnaire. A referendum style question was employed and individuals were given the option of choosing to pay a randomly selected bid (tax change) and accepting the program, not paying the bid amount and not accepting the program, or responding "I don't know." Respondents were also asked a number of debriefing questions in the fashion suggested by the NOAA panel (Arrow et al , 1993). Appendix A contains a sample of the CV question.

The choice experiment questions were designed from the attributes of the situation - caribou populations, wilderness area, recreation restrictions (a categorical variable), forest industry employment and a change in provincial income taxes. These 5 attributes, each having 4 levels, form the basis for the design of the choice experiments (Table 1). Additional attributes, designed as being perfectly collinear with these initial 5, were also included in the scenario descriptions. These attributes include moose populations (included because the area is a popular moose hunting region and because moose populations and caribou populations are strongly negatively correlated) and FMA area (included to illustrate that increases in wilderness area arise from reductions in FMA area). The attributes, and the methods of describing each attribute, were constructed through consultation with biologists and forest managers, and were subsequently tested and refined using focus groups. The 4 levels of each attribute reflect the current levels of the attribute, one level below, and two levels above current conditions.

The set of attributes used in the choice experiments spanned the levels of attributes used in the CV question. Thus, the CV question essentially forms one attribute set within the CE. The fact that attributes varied above and below current levels also allows us to examine both WTP situations and WTA situations. In some of the choice sets, the combinations of tax increases and environmental quality improvements appear to be WTP situations (relative to the current situation or status quo). However, there will also be choice sets in which reductions in environmental quality and tax payments occur as they would in a WTA situation. While a complete analysis is somewhat beyond the scope of this paper, in the discussion section we explore the implications of structuring both scenarios within a single framework. In particular, it is possible to examine the model for evidence of “endowment effects.”

Each respondent was presented with 8 choice scenarios and was asked to choose between the current situation (defined by current attribute levels) and one of two alternative situations (defined by varying levels of the 7 attributes described in Table 1). The scenarios were constructed from a $4^5 x 4^5 x2$ orthogonal main effects design (see Adamowicz, et al, 1995 or Louviere, 1988a for details on experimental design) and 4 versions of the survey were constructed from this design . An example choice scenario is provide in the appendix.

The survey also contained various attitudinal questions and demographic information questions, including household income. Two other forms of valuation questions, a payment card and another choice task, were also included but are not analyzed in this paper. The survey package included the survey booklet, a map of the areas, a separate glossary describing attributes and levels in more detail, and a summary sheet.

The survey was conducted on a random sample of the residents of Edmonton, Canada. Initial telephone contacts were established to recruit individuals to complete a mail questionnaire. Random digit dialling was used to contact 900 who agreed to complete the survey. The surveys were sent to these individuals and they received reminder cards[1] after 2 weeks. After 4 weeks those who did not respond to the survey were sent new survey packages. The response rate was 65%, which is admirable given the complexity of the survey. Approximately 90% of those who responded provided complete information on the choice experiment and CV questions. These individuals were used for the statistical analysis.

[1] As a methodological test we sent half of the sample reminder cards and telephoned the other half to remind them to complete the survey. There appears to be no significant difference between the two in terms of response.

Model Specification and Estimation

The CE structure and the referendum CV structure can both be analyzed using a random utility model. In each case, the choice of an alternative (1 of 3 scenarios in the choice experiment or Yes/No in the CV experiment) represents a discrete choice from a set of alternatives. Each alternative is hypothesized to have utility associated with it of the form:

$$U_i = V_i + \epsilon_i \ . \qquad \textbf{(1)}$$

This utility is comprised of an objective component (V_i) and an error component (ϵ_i). In the CE, the V_i contains attributes of the situation while in the CV model V_i contains the "bid" and an intercept.[2] Assuming a type I extreme value distribution for the error terms, the probability of choosing alternative i becomes:

$$Pr\{i\} = \frac{e^{sV_i}}{\sum_{j \in C} e^{sV_j}} \ , \qquad \textbf{(2)}$$

where C is the choice set (the three alternatives in the choice experiment and either Yes or No in

[2] The choice experiment utilities also contain alternative specific constants. In the linear forms of these models, demographic variables such as income drop out, unless they are included in an alternative specific fashion. We examined the inclusion of various demographic variables in the CV model but found that the only statistically significant factor was membership in conservation organizations. Furthermore, only a small sample of individuals had this characteristics. Therefore, for the linear models used in this paper, only bid and an intercept as included in the CV model. When the quadratic form is used, both the choice experiment and the CV models also include income. While further investigation into the inclusion of demographic variables into both the CV model and the CE models is necessary, the results presented here may be considered a reasonable comparison since these elements are not included in either approach.

the CV model) and s is the scale parameter. In any single sample the scale parameter can not be identified, and thus is assumed to be 1. However, in separate samples (or across separate data types) one can compute the relative scale parameter which accounts for the difference in the variation of the unobserved effects (Swait and Louviere, 1993; Adamowicz et al, 1994; Hensher, 1994).

Since each type of choice task (CV or CE) is consistent with random utility theory, and since the choices are being made over the same types of situations, we can also combine the data sets and examine the relative scale effects. There are two reasons for doing so. First, we can test to determine if the parameters of the two models are equal, once error variance heterogeneity is accounted for.[3] Second, given that the scale parameter is inversely related to the variance of the unobserved component (Swait and Louviere, 1993), we can determine which model has the higher variance of the unobserved component and if the two approaches have significantly different error variances.

In previous research examining scale parameters, grid search approaches were used to estimate the maximum likelihood scale parameter (Swait and Louviere, 1993; Adamowicz et al, 1994). In this study we utilize an approach outlined by Hensher and Bradley (1993) to obtain full information maximum likelihood estimates of the scale parameter, along with all other parameters. The approach is illustrated in Figure 1. An artificial nested logit tree structure is developed where each alternative (in the choice experiment and the CV models) is treated as a single branch. Thus, each branch has only one alternative and the inclusive value for each branch becomes the scale

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[3] In this case we are testing the marginal utility of income between the two models. Since all of the environmental attributes are lumped into the intercept in the CV model we cannot test similarity between other attributes.

parameter. The CE alternatives have their inclusive values constrained to 1 while the inclusive value parameters on the CV alternatives are constrained to be equal, but are unconstrained in terms of value. Thus, the scale parameter on the CV branches becomes the relative scale parameter for the model. Note that these inclusive value parameters do not carry the same interpretation as inclusive value parameters in nested logit models and their values can exceed unity without violating the consistency of the model with random utility theory (see Hensher and Bradley, 1993 or Bradley and Daly, 1994 for details). Restricting the scale parameters for all branches to unity produces a model that constrains the parameters to be equal and restricts the variance of the unobserved components to be equal as well.

In summary, three types of models were estimated using two different functional forms. The three model types are (1) Choice Experiment (CE), (2) Contingent Valuation (CV), and (3) Combined CE and CV accounting for heterogeneous scale effects (Joint: Scaled). The two functional forms are linear and quadratic. In the quadratic model all attributes and their squares are included in the CE utility functions and the monetary variables, (income-tax) and $(\text{income-tax})^2$ are included in both CV and CE models. Four hundred and two respondents provided valid responses to the CV questions and 447 respondents completed the CE task. All attributes in the CE and joint models are entered as continuous variables, except for recreation restrictions which are categorical and included using effects codes (the utility of the 4th level of restrictions is the negative sum of the utilities of the first 3 levels of restrictions.).

Results and Discussion

Estimation results are presented in Table 2. The CV results in both the linear and quadratic case, are as expected. The intercept is positive and the bid coefficients are negative and significant. The quadratic term is not significant, indicating that the marginal utility of income is constant (at least over the range examined here).

The linear CE model also performs as expected. In the linear model, caribou population and wilderness area have significant positive coefficients. The coefficients on recreation restrictions decrease as the restrictions become more severe[4]. The coefficient on tax is negative and significant, as expected. Employment is not significant in the model. There are three possible reasons why employment is not statistically significant. First, the survey was conducted in Edmonton and the employment levels being affected are in areas several hundred kilometres outside of Edmonton. Second, the number of jobs at stake is probably not enough to suggest that effects will be felt in Edmonton. Third, respondents were told that part of their increase in tax payments may go to fund retraining programs (as well as caribou management programs).

The quadratic CE model outperforms the linear model (a restriction of the quadratic terms to zero is rejected) but produces qualitatively similar results. Utility for caribou populations and wilderness area is increasing at a decreasing rate (although the quadratic term on wilderness area is not significant). Employment is still not significant. Utility over income is also increasing at a decreasing rate.

The attribute coefficients of the joint linear model differ very little from those of the CE linear model. In the joint - scaled model, where the CV model is scaled to match the CE model

[4] Since all attributes are included in the survey as categories, these models could be estimated using effects codes (or dummy variables) for all factors, not just recreation restrictions. Interestingly, a graph of utilities from a linear, effects coded and quadratic model shows that the effects code model and the quadratic model are very similar. Therefore, the quadratic model probably is the best representation of preferences.

variance, the parameter on tax is restricted to be the same between the two data types. Since this joint estimation involves the release of one restriction (the scale effect) and the imposition of another (identical tax parameters) one cannot say if the two data sets, under the assumption of heterogeneous scale effects, have the same parameters. However, assuming parameter equality, we can assess the size of the relative scale effect. The relative scale parameter is 2.06, indicating that the CV model has a lower variance of the unobserved effects. However, this value is not significantly different from 1, indicating that the error variance components are not significantly different.

The joint - scaled quadratic model is also quite similar to the CE quadratic model. The scale parameter (1.48) is positive, indicating that the quadratic CV model has a lower error variance. However, this value is not significantly different from unity. Thus, the CV and CE models appear to have error variances that are not significantly different. In the quadratic case we tested for equality of parameters subject to scale heterogeneity and the likelihood ratio statistic is 2.18 with 1 degree of freedom (not significant at a 5% level). Therefore, the parameters in the CV and CE quadratic models are not significantly different, when one allows for scale heterogeneity.

The fact that the CV and CE models have the same underlying preference structure (at least for the income portions of the utility functions) is interesting and suggests that the marginal utility of income indicated by the two models is not different. However, the two models may be producing different results in terms of the preferences over other attributes. In order to examine these differences the welfare measures associated with caribou population improvements were estimated for the models.

Median welfare measures are calculated from the CV model (Hanemann, 1984).[5] For the CE and joint models the welfare measures are calculated as the amount of income (payment) required to make the average individual as well off with the environmental improvements as they are with the current situation.[6] The improvements are defined using the description of the program outlined for the CV question. Note that since employment was insignificant in the estimated models it is not included in the welfare calculations.

The welfare measures and their standard deviations[7] for the models described above are presented in rows 1-3 in Table 3. In the linear model, the CE and joint welfare measures are approximately half of the CV measure and the CE and joint measures are somewhat less variable. The quadratic model welfare measure is higher than those for the linear models. This is especially pronounced for the CE and joint models, which is not surprising given that the quadratic forms show a marked nonlinearity in the caribou attribute. This can be seen in Figure 2 where utility over levels of the caribou attribute for linear, quadratic and an effects coded model is plotted. Note that in the range from 400 to 600 caribou (the range specified as the "program" in the CV question) the quadratic model identifies a much larger change in utility than the linear model. This change is responsible for the difference between the two welfare measures. Comparison of the

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[5] Since it is possible that individuals would rather maintain local employment conditions and current levels of recreation restrictions rather than enhance caribou habitat, the possibility for negative willingness to pay measures in the CV structure exists. In a case where benefits can be negative, the median welfare measure (as described by Hanemann, 1984) is appropriate.

[6] In calculating these welfare measures we disregarded the intercept in the CE and joint models and focused on the values associated with changes in attributes. In the following section, however, we turn our attention to the role of the intercept term in welfare measurement.

[7] The standard deviations are calculated from 1000 draws from a distribution defined by the coefficients of the respective models.

shape of the utility surface associated with wilderness area between the linear and quadratic models, on the other hand, shows relatively little difference (see Figure 2). Furthermore, the quadratic term on “money” evaluated at the average income level, does not produce marginal utilities of income that differ markedly from the linear marginal utilities of income. Therefore, the large increase in the welfare measure from the linear to the quadratic CE and joint models seems to be due entirely to the nonlinearity of preferences over caribou.

We suspect that the nonlinear shape of the utility of caribou is due to the background information provided to the respondents. This information stated that 400 caribou was the current population level, but that wildlife biologists suggest that 600 is the minimum required for a viable population (small risk of extinction). Thus, it is not surprising to see that the marginal utility of caribou declines dramatically after a population of 600 is reached. If the “program” had been a move from 600 to 800 caribou, the welfare change would have been more modest.

“Endowment Effects” in the CE Model

An examination of the CE and joint model parameters reveals a negative and significant intercept for the non-current situation alternatives.[8] In other words, the utility associated with moving away from the current situation is negative and significant. This can be considered a form of endowment effect (Kahneman and Knetsch, 1990) and appears to be a fundamental feature of the choice behaviour of respondents in our analysis.

The utility associated with the current situation could be due to a mis-trust of the

[8] Note that the values for the alternative specific constants could have been specified separately (one for each of alternative A and B) but since A and B are designed using an orthogonal design procedure, these intercepts should not differ. Indeed, a statistical test of this restriction is easily accepted.

administration or doubts over the ability of resource managers to carry out the programs as described. Alternately, it could be that individuals chose the current situation (or status quo) response when the task of selecting options was too complex or they were uncertain about the tradeoffs they would be willing to make. Choosing the current situation could also be a form of protest response. In the welfare measures described above, this negative association with movement away from the current situation was not included - only changes in the attribute levels were included. If we had included the negative intercept in the welfare calculations, all of the CE and joint models would have produced negative welfare measures for the proposed environmental change. Thus, in this process we essentially assumed that the welfare change could be calculated based on attributes alone, and ignored the endowment effect[9]. This may be a reasonable strategy if the strong negative intercept is a result of a segment of sample always choosing the current situation, effectively not making choices.

We examined the data and discovered that a portion of the sample did in fact always choose the current situation, regardless of attribute levels. We removed this portion of the sample and re-estimated the models. The results on the smaller data set (355 individuals) are qualitatively very similar to the full sample CE and joint results except that the size of the intercept term is reduced (in absolute value). Columns 4 and 8 in Table 2 present the linear and quadratic joint - scaled model based on this reduced data set. The intercept term is still negative and significant, indicating some degree of endowment effect. The scale parameter continues to indicate that the

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[9] Note that estimating these models without an intercept (or equivalently with a constraint that the current situation and alternative utilities are equal if all attributes are equal) will produce a biased set of coefficients because the attributes themselves will be attempting to explain the larger proportion of status quo choices, rather than the alternative specific aspects of the design.

CV error variance is smaller than the SP error variance but that this difference is not significant. The hypothesis of parameter equality, after accounting for variance heterogeneity, is still accepted.

The welfare effects from the reduced sample joint - scaled models are presented in rows 5 and 6 of Table 3. These welfare effects are presented with and without intercept effects. Since the reduced sample models do not contain individuals who may have been protesting, the intercept effect may now be more of a "real" phenomenon. Thus, including the intercept effect in this case seems to be a reasonable option. In the linear model, the welfare measure is negative, indicating that the environmental change is not welfare enhancing. In the quadratic model, however, the welfare measure is positive and about half the size of the CV measure. Note that the welfare measures calculated without the intercept effects are quite comparable to, although slightly larger than, those calculated from the full sample.

Evidence of endowment effects also arise in other parts of the CE models. The quadratic model shows that utility is increasing at a decreasing rate for the wilderness and caribou attributes. Specifying the model using effects codes allows one to examine, in a somewhat simple fashion, changes from the current situation[10]. Parameters on effects codes for the 4 levels of the caribou attribute (50, 400, 600, 1600 caribou) are -1.217, .262, .723 and .232 respectively. Note the significant disutility associated with the drop from the current level of caribou (400) to a level of 50. Interpolating between the ranges implies a marginal utility associated with caribou losses of -0.004 and a marginal utility of caribou gains of 0.002. As expected, the disutility associated

[10] This model is not presented because of space considerations. The results are available from the authors.

with a loss is greater than the utility of a gain. Similarly for the wilderness attribute, an examination of the effects codes suggests a marginal utility of -.1319 per unit for losses from the current level and a marginal utility of .028 per unit for gain. These relationships are illustrated in Figure 2. The reduction from the current level of wilderness area (15 in Figure 2) is associated with relatively steep declines, while increases in wilderness area are not associated with sharp increases in utility.

Endowment effects on income can also be investigated using the CE model. Since both tax reductions and tax increases are used in the choice experiment, one can examine the utility of an increase versus a decrease in taxes. Re-estimating the CE model with a dummy variable to reflect alternatives that have tax decreases rather than tax increases, and interacting this variable with the tax value itself, generates a new variable that can be used to calculate the marginal utility of tax increases versus tax reductions. Using the linear functional form we found that the marginal utility of a tax reduction is .009 while the marginal utility of a tax increase is -.007. While this suggests that the marginal utility of income losses is less than the marginal utility of income gains, the two marginal utilities are not significantly different. Therefore, we do not observe an endowment effect for money in the experiment.

Conclusions

Our objective was to employ a CE (stated preference) approach for measuring passive use values and to compare this approach with a CV exercise. Our results are encouraging in the sense that CE models perform well and that the preferences over income between the two approaches, once error variance is taken into account, are not significantly different. We also illustrated the use of nested logit software to jointly estimate parameters and relative scale factors in a FIML fashion.

The CE approach allowed us to examine values over attributes, impacts of functional forms over attributes on welfare measures, endowment effects, and other items that are difficult to examine in CV models. If endowment effects are ignored, a linear functional form CE model produced welfare measures that were somewhat lower than the CV measures and a quadratic CE model produced measures that were somewhat higher than those generated by CV . The CE models, however, allowed us to characterize these differences as being due to the nonlinear preferences for caribou population sizes. Respondents indicated that moving to the “sustainable” level of caribou is quite important, but movements beyond this level are not as important.

If endowment effects are included as part of the welfare calculation, the welfare measures from the CE models are smaller, with only the quadratic specification producing a positive value (using the reduced sample). The endowment effect results are fundamental in the calculation of welfare measures in our application. We believe that the challenge in understanding this finding is to examine the behaviour associated with choices of the current situation. Is the positive utility associated with the current situation a true endowment effect or is it some form of protest response? Is the repeated choice of current situation the result of respondent fatigue? Alternately, there may be groups of individuals who have different preferences over the set of attributes presented in our experiment, and the aggregation of all individuals in our sample has produced this particular response. There may be several segments within the population and we are only capturing the mean effect over the groups. Clearly, there is room for additional research on these topics. Note that we could have avoided the endowment effect by simply designing the experiment such that individuals chose from two hypothetical (future) scenarios. However, this would have eliminated what we believe to be an interesting part of the analysis.

In conclusion, our comparison of CV and CE in a passive use application shows similarities in income preferences between both models, but some interesting differences in response to environmental attributes. The CE model also illustrated the presence of endowment effects in our sample, a phenomenon that is difficult for CV to uncover. To discover these findings we applied a modification of nested logit estimation which allowed us to jointly estimate the CV and CE models. Adding CV data to the CE model, while accounting for variance heterogeneity, resulted in little improvement over the CE model alone. The analysis revealed that the CE approach provided a richer description of preferences over environmental attributes, and thus may provide a superior alternative to CV in some cases.

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Table 1. Attributes and Levels Used in the Choice Experiments

Attribute	Levels
Mountain Caribou Population (number of caribou)	50 400 **(current situation)** 600 1600
Wilderness Area (hectares)	100,000 150,000 **(current situation)** 220,000 300,000
Recreation Restrictions (categories)	Level 1 No restrictions Level 2 Activities in designated areas **(current situation)** Level 3 No hunting, fishing, off-road vehicles, helicopters; horses and overnight camping in designated areas Level 4 No hunting, fishing, off-road vehicles, helicopters, horses; hiking on designated trails, limited access overnight camping.
Forest Industry Employment (direct employment)	450 900 1200 **(current situation)** 1250
Changes to Provincial Income Tax (annual change)	$50 decrease No change **(current situation)** $50 increase $150 Increase
Additional Attributes **(confounded with attributes above, listed to make descriptions complete).**	
Moose Populations	14,000 8,000 6,000 2,000
Forest Management Agreement Area (hectares)	1,061,000 1,012,000 942,000 862,000

Table 2. Coefficients of Linear and Quadratic Contingent Valuation and Choice Experiment Models

	Linear Model				Quadratic Model			
Variable	CV	CE	Joint - Scaled	Joint-Scaled Reduced Sample[c]	CV	CE	Joint - Scaled	Joint-Scaled Reduced Sample[c]
Intercept - CE		-1.0940 (-15.81)	-1.0940 (-15.81)	-0.6740 (- 9.19)		-0.9196 (-12.13)	-0.9157 (-12.10)	-0.4679 (-5.73)
Intercept - CV	0.9426 (4.25)		0.4561 (4.40)	0.4666 (4.38)	0.9421 (4.25)		0.5373 (3.53)	0.5289 (3.68)
Caribou		0.0467 (9.15)	0.0467 (9.15)	0.0501 (9.25)		0.5189 (17.47)	0.5188 (17.47)	0.5453 (17.71)
Caribou Squared						-0.0256 (-16.67)	-0.0256 (-16.67)	-0.0269 (-16.85)
Wilderness Area		0.0340 (8.58)	0.0340 (8.58)	0.0391 (9.33)		0.0649 (2.08)	0.0649 (2.08)	0.0756 (2.30)
Wilderness Area Squared						-0.0008 (-1.03)	-0.0008 (-1.03)	-0.0009 (-1.16)
Recreation Level 1[a]		0.3047 (6.28)	0.3047 (6.28)	0.3334 (6.55)		0.2768 (5.47)	0.2768 (5.47)	0.2786 (5.22)
Recreation Level 2[a]		0.1622 (3.25)	0.1622 (3.25)	0.1669 (3.23)		0.1710 (3.24)	0.1723 (3.27)	0.1759 (3.17)
Recreation Level 3[a]		-0.1964 (-3.63)	-0.1964 (-3.64)	-0.2168 (-3.87)		-0.1556 (-2.85)	-0.1557 (-2.85)	-0.1504 (-2.65)
Employment		0.0037 (0.39)	0.0037 (0.39)	0.0080 (0.81)		0.0663 (0.81)	0.0673 (0.83)	0.1340 (1.57)

Employment Squared						-0.0048	-0.0049	-0.0087
						(-1.01)	(-1.02)	(-1.74)
Tax [b]	-0.0066	-0.0032	-0.0032	-0.0033	-0.0072	-0.0056	-0.0053	-0.0051
	(-2.79)	(-7.64)	(-7.64)	(-7.54)	(-2.26)	(-6.35)	(-5.79)	(-5.38)
Tax Squared [b]					-0.0001	-0.0003	-0.0002	-0.0002
					(-0.27)	(-3.23)	(-2.62)	(-2.24)
Scale Parameter (S_1)			2.0663	2.0200			1.4777	1.5633
			(2.62)	(2.62)			(2.16)	(2.23)
Rho^2	0.04	0.16	0.15	0.09	0.04	0.20	0.19	0.13
Log-Likelihood	-266.67	-3312.38	-3579.04	-3107.35	-266.63	-3143.65	-3411.37	-2936.73
% Correct Predictions	53	45	46	41	53	48	48	45

[a] Effects coded variable. The parameters on the fourth level of recreation restrictions is the negative sum of these three parameters.

[b] Linear "Tax" variable represents (Income - Tax) but is estimated using tax only (since income is constant across alternatives). Quadratic tax variable is ($(\text{Income} - \text{Tax})^2$ / (10000)).

[c] Reduced sample indicates that individuals who always selected the current situation option were removed from the analysis.

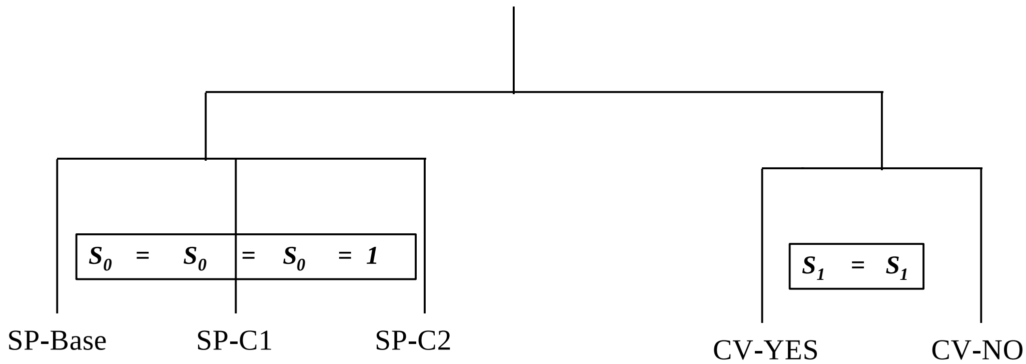
Table 3. Welfare Measures for Caribou Management Program

Model	**Linear Form**	**Quadratic Form**[b]
Contingent Valuation	142.82 (66.09)[a]	140.86 (1504.85)
Choice Experiment	76.50 (34.32)	190.10 (48.30)
Joint Model - Scaled	76.50 (34.19)	187.30 (45.74)
Joint Model - Scaled Reduced Sample		
Intercept Effect Excluded	92.02 (35.94)	209.35 (46.66)
Intercept Effect Included	-105.18 (33.88)	75.42 (27.92)

[a] Standard deviations in parentheses were calculated from 1000 draws from the distribution of the coefficients in each model and constrained to be less than sample average income.

[b] Quadratic welfare measures are evaluated at the sample average income.

Figure 1: Artificial Tree Structure for Joint Model Estimation



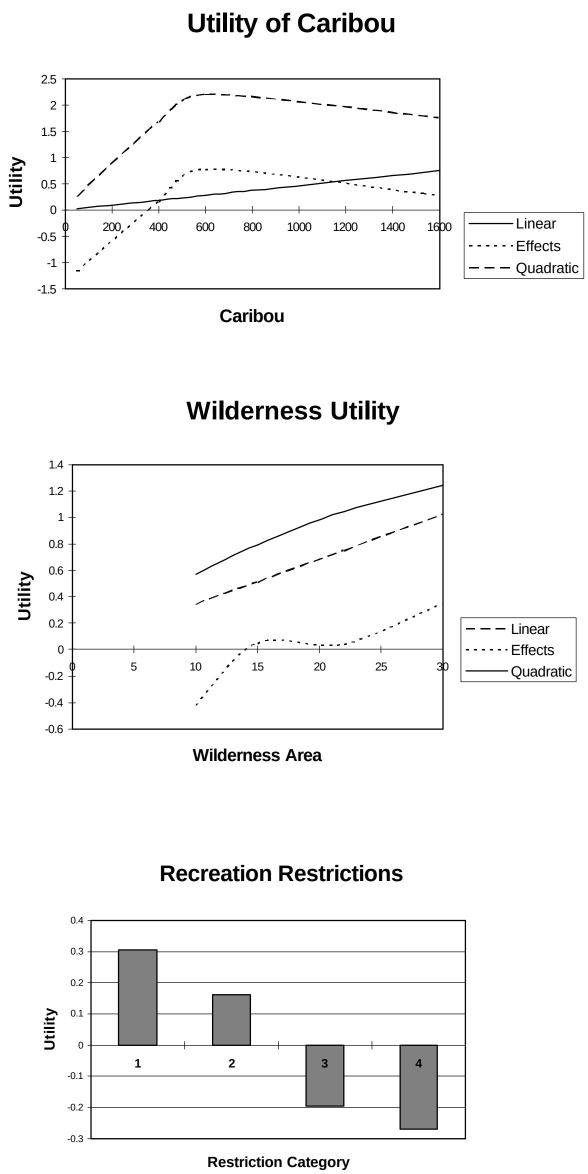


Figure 2: Utilities from Choice Experiment Models

APPENDIX

Option Set 1: A Referendum on Old Growth Forest Preservation

1. Suppose the decision of implementing the Old Growth Forest Preservation Program was to be based on a vote or referendum. If the majority of Albertans were in favour of the program, it would be approved and become law. If you were asked to vote on the old growth preservation program, and it cost **each Alberta household $________ per year** in increased income taxes to fund the program, would you vote yes or no? *(Choose one only below)*

- ☐1 YES *(Please go to question #1a.)*
- ☐2 NO *(Please go to question #1b.)*
- ☐3 I DON'T KNOW *(Please go to question #1c.)*

1a. **If you chose YES**: Why did you vote for the Old Growth Forest Preservation Program? *(You may choose more than one)*

- ☐1 I believe that old growth forests are valuable and should be preserved.
- ☐2 I do not really have to pay this amount but I still support old growth preservation.
- ☐3 I do not really think that forestry firms will suffer.
- ☐4 I do not think this is too much to pay for the benefits I receive.
- ☐5 Other *(please specify)* ____

Please proceed to the next page ...

1b. **If you chose NO**: Why did you vote against the Old Growth Forest Preservation Program? *(You may choose more than one)*

- ☐1 I think this is an important issue but I feel that the funding should come from the existing taxbase.
- ☐2 I do not believe that the old growth forests are worth that much.
- ☐3 I do not think that the preservation proposal will be successful.
- ☐4 I can not afford it.
- ☐5 I do not really believe that the old growth ecosystem is threatened.
- ☐6 I think that this proposal will adversely affect the forest industry / local communities.
- ☐7 I think that industry should take the initiative and responsibility in conservation and environmental issues.
- ☐8 I think payment should be on a voluntary basis (for example, donations to an environmental organization that supports old growth habitat and wildlife conservation).
- ☐9 Other *(please specify)* ____

Please proceed to the next page ...

1c. **If you chose I DON'T KNOW**: Why did you choose this category? *(You may choose more than one)*

- ☐1 I need more information to make such a decision.
- ☐2 I think this question is morally offensive.
- ☐3 I think the situation presented is too hypothetical.
- ☐4 Other *(please specify)* ____

Alberta Forests: A Choice Of Futures

In the following exercise we would like you to reveal your opinions about issues surrounding conservation programs and industry development. We would like you to compare the current state of the forests and wildlife in Alberta against two future options. You will be presented with eight (8) sets of such present/future options that examine forestry and wildlife issues in West-Central Alberta (Edson, Hinton and surrounding areas). Each set of options will be described by attributes such as various populations of moose and caribou, different sizes of areas under Forest Management Agreements (FMA); more or less jobs in the forest industry; and/or changes in income taxes per household. Tax levels may increase because money may be required for retraining and relocation of local workers, compensation for the removal of land from current FMAs, increased costs of management of wilderness areas, intensive management of wildlife species like woodland caribou and/or increased costs of management of recreation activities. Tax levels may also decrease if additional revenues are generated (from forestry, other industrial activity, or recreation and tourism).

For each set of options presented, we would like you to select one option which you would choose for Alberta.

PLEASE REFER TO THE GLOSSARY PROVIDED FOR DEFINITIONS AND CLARIFICATION.

Example:

Attributes	Current Situation	Alternative Situation 1	Alternative Situation 2
Mtn Caribou	400 caribou	1600 caribou	600 caribou
Moose Population	8,000 moose	2,000 moose	6,000 moose
Wilderness Area	150,000 hectares	150,000 hectares	220,000 hectares
FMA Area	1,012,000 hectares	1,012,000 hectares	1,012,000 hectares
Recreation Restrictions	Level 2	Level 2	Level 1
Forest Industry Employment	1200 jobs	1200 jobs	1200 jobs
Provincial Income Tax Change	No change in taxes/year	$50 increase in taxes/year	$50 decrease in taxes/year

Choose One Only: ☐ 1 ☐ 2 ☐ 3