A Box-Cox double-hurdle model of wildlife valuation: the citizen's perspective.

Roberto Martínez-Espiñeira
Department of Economics, St. Francis Xavier University

June 2004

Corresponding address: Department of Economics, St Francis Xavier University, PoBox 5000, Antigonish, Nova Scotia B2G2W5 CANADA, e-mail: rmespi@stfx.ca, Tel: 1-902-867-5443, Fax: 1-902-867-3610

Abstract

A stated-preference approach is used to elicit the attitudes of the general public towards coyotes conservation. The payment vehicle is presented in a way that explicitly prompts individuals to adopt a citizen perspective, rather than a consumer perspective, when responding to the survey. To deal with the large numbers of zero responses, a Box-Cox Double Hurdle specification is used to model separately individuals' choices about whether to support conservation or not and their choice about the degree of support. The results show that simpler analyses that do not account explicitly for this two different decisions would lead to misleading conclusions in the study of nuisance wildlife. The study uses a survey conducted in Prince Edward Island (Canada).

Keywords: Coyotes; wildlife valuation, citizen versus consumer preferences; payment-vehicle; Box-Cox, double hurdle

JEL codes: Q20, Q26

Acknowledgements: *Peter Moffatt and Julian Fennema provided me with invaluable help with the programming of the econometric procedures used. Crystal Pentz and Chris Reid helped conducting the phone survey. Any erros or omissions and all views expressed remain my sole responsibility. The project was funded by UCR grant No. 1308 St. Francis Xavier University.*

1 Introduction

Non-consumptive values derived from wildlife cannot be readily elicited from the observation of market transactions. However, when policy debates arise on the desirability of wildlife preservation (or removal), it is essential to have an idea about how much society considers right for the government to spend in order to promote conservation (or removal) of wildlife. Traditionally, the contingent valuation method has been suggested as the tool to estimate the value placed on wildlife species, under the assumption that individuals, when presented with hypothetical markets, reveal their individual willingness to pay for the resource, as they would do in the case of any conventional private good. From the individual valuations, the method aggregates into a social valuation measure.

In this paper, we model the attitudes of residents in Prince Edward Island (PEI) towards coyotes in terms of their stated support of an increase in taxes to fund a coyote protection scheme. Recently, there has been some debate in this Canadian province about whether a bounty should be imposed on coyotes to reduce the costs they allegedly impose on the sheep-farming industry. However, there is no study available about the non-use benefits of coyotes in Canada.

This paper departs from the conventional contingent valuation approach in a crucial respect. The payment vehicle explicitly prompted respondents to adopt a social viewpoint when answering the valuation question. In this sense, the problem of distinguishing between citizen versus consumer preferences when dealing with environmental goods was avoided (Blamey et al. 1995; Sagoff, 1998; Nyborg, 2000). To the author's knowledge, this is the first time that this approach is used in the case of wildlife. The drawback of this approach is that the results of the valuation process cannot be understood in the same sense as those resulting from a traditional contingent valuation process, whereby respondents are assumed to adopt a purely-private consumer viewpoint.

However, rather than focusing on the valuation of the species, the paper focuses on the explicit distinction between factors affecting whether individuals state that they support coyote conservation and factors that affect the stated degree of support. This is especially relevant in this case, since some individuals consider coyotes a public bad instead of a public good. This is achieved by using a Double-Hurdle specification when modelling individuals' responses as a function of socioeconomic and attitudinal characteristics of each respondent. A growing number of studies deal with this issue in the case of dichotomous-choice analysis (based on so-called Spike Models[1]), but almost no attention has been paid to the case of analyses that employ open-ended questions. Reiser and Schechter (1999) note the lack of studies addressing the problem of non-participation in studies based on open-ended questions, while Langford et al. (1998) constitute a rare exception to this trend.

The results show that this more flexible specification explains better the support individuals say would give to coyote conservation. The variation in stated bid values is explained by sociodemographic variables of the individuals and of their county of residence, and by the individuals' attitudes towards wildlife.

The next section describes some previous studies dealing with the valuation of wildlife species and the debate about the use of contingent valuation studies on the base of stated consumer versus citizen preferences. The data collection process is described next. The theoretical model and a summary of the econometric exercises follows. Finally, the results are discussed and some conclusions extracted.

2 Background

Perhaps the most commonly used stated-preference method to estimate non-consumptive values is the contingent valuation method (CVM). This consists of directly asking people to state the value they place on the change of quantity or quality of a certain environmental resource. This method has been widely applied during the last decades (see, for further theoretical details and reviews of empirical applications, Mitchell and Carson, 1989; Braden and Kolstad, 1991; Freeman, 1993; Hanemann, 1994; Diamond and Hausman, 1994).

Many CVM studies have been applied to other wildlife species, endangered species in particular (Brookshire et al., 1983; Boyle and Bishop, 1987; Jakobsson and Dragun, 2001).[2] However, only a few studies focus on the contingent valuation of coyotes. Stevens et al. (1991, 1994) find that twenty-three percent of respondents would pay US$ 5.35 to protect coyotes, while nineteen

[1] See Kriström (1997) for example.

[2] See Loomis and White (1996) for a meta-analysis of contingent valuation studies concerned with endangered species.

percent would pay US$ 4.20 to control them. More numerous are the available examples of valuation of another, perhaps more glamorous wild canid: the wolf. These include Duffield (1992); Duffield and Neher (1996); Boman and Bostedt (1999); Jorgensen, et al. (2001); and Chambers and Whitehead (2003).

A fundamental assumption adopted by these traditional CVM models is that individuals' responses may be interpreted as expressions of consumer preferences. However, this assumption has been subject to challenge (Stevens et al., 1991; Kohn, 1993, Common et al., 1997). This is because respondents to CVM surveys could be actually stating their preferences as *citizens*, based on some notion of social responsibility, rather than as consumers concerned with the maximization of individual welfare. Individuals may consider that social decisions provide an opportunity to give higher (or lower[3]) valuations than what they would choose, for one reason or another, to give in their private activities (Kelman, 1981). This might be a problem affecting especially those cases in which the context is likely to suggest that respondents act in a 'citizen mode.' For example, dichotomous choice procedures based on referenda, the use of taxes as payment vehicle, and the valuation of policies or goods that have been the subject of public debate move away from a pseudo-market setting towards a political choice one (Blamey et al. 1995; Blamey, 1996). Similarly, a survey worded with a focus on the respondent's moral responsibility as a social agent may induce more respondents to take a social point of view and the choice of payment vehicle may provide clues to whether other individuals are supposed to pay or not (Nyborg, 2000).

Conventionally, CVM studies try to derive measures of value based on the notion that the respondents adopt a utility-maximizing behavior when responding to the valuation question. However, CVM respondents are unlikely to properly assess (much less maximize) the utilities derived from non-market goods, consider the prices of other goods, or appraise their income as a realistic constraint. As Sagoff (2003) points out, studies that investigate the motives behind WTP for environmental goods consistently show that people base their preferences less on what they believe will benefit them than on what they judge is good in itself, meets certain standards or

[3]It is likely that someone directly affected by a life-threatening health condition would privately support research towards a cure with an infinitely high amount. However, from a social point of view, that person would favor only a limited expense devoted to that research by the government.

norms, suits the identity or character of their community, or conforms with principles appropriate to the circumstances (Perrings, 1995, p. 836). Responses to contingent valuation questions about environmental preservation are likely to be dominated by citizen judgements concerning social goals and responsibilities, rather than by consumer preferences (Blamey et al. 1995). This problem would be expected to affect especially the context of wildlife valuation.

Sagoff (1988) argues that the literature on CVM fails to distinguish between the individual's roles as consumer and as citizen. Individuals report that they base their willingness to pay for public goods with aesthetic or spiritual significance on their concerns as citizens more than on their wants as consumers (Sagoff, 1998):

> As a citizen, I am concerned with the public interest, rather than my own interest; with the good of the community, rather than simply the well-being of my own family. (...) In my role as a consumer, (...) I pursue the goals I have as an individual' (Sagoff, 1988, p. 8)

This pervasive influence of citizen, rather than consumer, preferences has posed a theoretical problem in contingent valuation studies (Blamey, 1998).

In this paper, respondents were asked how much they thought it would be reasonable to ask all PEI residents to contribute to a program to protect coyotes based on compensating farmers for livestock losses through an annual tax.[4] The responses to the valuation question were coded as the variable *tax* (see the Appendix for a list of variable definitions).

This formulation of the question clearly deviates from the definition of willingness to pay. On the other hand, it facilitated the calculation of a response in the open-ended context. Often respondents find it hard to understand the concept of reservation price of willingness to pay for voluntary donations, let alone taxes. Moreover, in the case of taxes, it is likely that respondents would consider not the maximum tax they would pay before withdrawing their support for the program (which is what discrete-choice analyses of the referendum type would usually try to elicit) but some perceived-fair amount that every taxpayer should contribute. Their responses

[4] *If farmers were to be compensated for the loss of livestock to coyotes and a compulsory tax were imposed on all PEI residents to fund the conservation of coyotes, how much would you say would be a reasonable annual contribution?* was the exact wording of the question.

would end up being more related to a personal judgement about acceptable fair shares than to the value placed on the resource. As expressed by Ajzen et al. (2000):

> The specific amount of money that the respondents would be willing to contribute is expected to reflect the amount of money that they consider to be fair or equitable under the stipulated circumstances. Unlike a private good, a public good or service benefits a broad segment of a community or society. People are therefore likely to believe that its cost should be borne fairly by all those who are responsible for the needed investment or who benefit from it. (Ajzen et al. 2000)

This formulation explicitly reflected these concerns and therefore, the stated values do not represent expressions of individual maximum willingness to pay.[5] In fact, they could be considered closer to what would be asked under a values jury approach (Brown et al. 1995; Sagoff, 1998). The respondents were told that the proceeds of the tax would be used to compensate farmers for their losses due to coyote predation. In that sense, responds could be interpreted as an *ethically efficient* compensating payment for sheep farmers for preserving coyotes. This is because they in effect are asked to state how much they would like their government to spend for coyote preservation (Kohn, 1993).[6]

Alternatively, the payment vehicle employed here could be seen as prompting the respondent to engage in a role as 'Homo Politicus with shared responsibility' as modeled by Nyborg (2000). This means that the respondents are forced by the wording of the valuation question to adopt a citizen role and suggest which amount they find socially right knowing that 'everyone is going to pay exactly the same.' By ensuring that all the respondents take the same point of view (as citizens rather than consumers) when stating their preferred amount the problem of aggregating apples and oranges when interpreting results is avoided.

However, in this sense, it is important to stress that the values obtained depart from what a conventional question about willingness to pay would obtain and cannot be seen as comparable to the results of conventional contingent valuation studies. Therefore, the focus of the paper

[5] If all or some of the respondents behave as citizens, it is not clear that the aggregation of their stated willingness to pay will yield a meaningful money measure of social benefits (Nyborg, 2000)

[6] Note that in Kohn (1993)'s formulation, this choice would be elicited in two separate steps.

lies not on the valuation issue nor the policy implications resulting from it, but rather on the modelling of citizens' judgements and attitudes when prompted to adopt a social perspective on wildlife conservation issues and on the methodological implications of using different types of econometric specifications to explain individuals' responses in this setting.

Econometric analysis was used to analyze the extent to which extent variations in the values of tax were influenced by differences in socioeconomic and attitudinal drivers. Since tax does not exactly correspond to a measure of conventional willingness to pay, not much guidance could be obtained from economic theory and earlier research on valuation to build the models. For example, it is often assumed that environmental conservation and wildlife conservation are normal goods. This suggests that the validity of WTP estimates to conserve coyotes could be investigated by checking that these WTP estimates were, for instance, positively correlated with the respondent's income. However, there would be no *a priori* expectation suggesting that richer individuals would find it socially desirable that *everyone* contributed a higher amount to a conservation project through taxation.

However, a similarity is to be expected between the sign (if not the magnitude) of the coefficients on drivers of conventional willingness to pay and the sign of the coefficients affecting tax. The main objective of this paper is to find out about the direction of these influences and in addition, to investigate whether there are any differences in sign between the drivers affecting the size of tax and those determining whether tax takes a null or a positive value.

A series of previous works are available on public attitudes towards coyotes. Kellert (1985) studied the public's attitudes towards coyotes and wolves. Stevens et al. (1994) studied perceptions about coyotes. These studies, among others, suggest that young, urban, female, wealthy, and more educated individuals tend to exhibit more favorable attitudes towards predators (Hewitt, 2001). Walsh et al. (1984) found WTP for wilderness conservation positively related to the level of education and that those who supported hunting and fishing would be willing to pay less for wilderness conservation. In principle, it would be reasonable to expect that the values of tax responded in a similar fashion to the effects of this type of variables.

In order to investigate this, multivariate regression models were used to model the correlation between the values taken by tax and a series of variables. Several candidates were available to build the models. These include attributes of the household and its county of residence (*age*, *agesq*, *male*, *income*, *incomesq*, *educat*, *livestock*, *sheep*, *cats*, *dogs*, *density*, *incometown*). A second type of variables (E) had to do with the respondents' previous experience with coyotes (*lastseen*, *problems*, *neighbours*), while *hunt* attempts to proxy respondents' attitudes towards wildlife. The general model estimated was of the form:

$$tax = f(S, E, A, I) \tag{1}$$

where *tax* is the bid stated in response to the socially acceptable level of taxation.

3 Data collection

A phone survey was conducted on a random sample of listed and unlisted residential phone numbers from all the counties in Prince Edward Island. The latest edition of the Island's phonebook was complemented with direct information from the company to find out about the up-to-date three-digit prefixes (exchanges) operative in each county. Calls were made from the hours 12:00 to 21:00, and during both weekdays and Saturdays. A male interviewer and a female interviewer conducted the survey. The guidelines suggested by Dillman (1978)) were followed during the different stages of the surveying process. A total of 235 contacts with eligible respondents were made, resulting in 155 completed questionnaires, a response rate of about 66%[7] (Dillman, 1978, p. 50). This response rate was quite reasonable in a survey targeting the general public.

In any contingent valuation survey, some targeted individuals will refuse to participate. This leaves open the possibility of non-response bias or sample selection bias. If respondents significantly differ from non-respondents in characteristics that influence WTP for the valued good, non-response bias may arise (Whitehead, et al., 1993). The average age of the respondents was 41. The average level of education of the respondents (variable *educat*) was 2.6 while the average for PEI is 2.[8] The average family *income* level was CAN$ 38,784 while it is CAN$

[7] Out-of-service numbers and commercial numbers were discarded (see Dillman, 1978, page 238-239). Calls meeting answering machines or no answer after five dial tones were retried once on a different day and discarded after two new failed attempts.

[8] Calculated from Stats Canada data for 2001 referring to individuals 15 years and older (Statistics Canada,

46,543 in PEI (Stats Canada). 45% of the respondents were female and 55% were male, while the average for PEI is 51% versus 49%.[9] Other summary variables are provided in Table 1. The comparison of the sample's summary statistics with those applicable to the whole province suggest that no systematic non-response bias should be expected, given the variables entering the econometric models. However, the typical individual in the sample seems to be more educated and the average family slightly poorer than their average counterparts in the population.

Apart from the questions on the sociodemographic characteristics of the respondent, additional questions about livestock ownership, pet ownership, attitudes towards hunting, and direct or indirect experiences with coyotes were asked to evaluate the influence of these effects on the attitudes towards coyotes.[10] The final models contained only a subset of these variables. This paper focuses on one of the last type of questions, which asked about the socially acceptable level of taxation earmarked towards the protection of coyotes.

For this question, an open-ended format was used. Dichotomous-choice or *close-ended* questions are supposed to result in less uncertainty, less 'don't know' answers, and lower proportions of outlier bids. However, close-ended questions tend to yield higher estimates of WTP relative to open-ended questions.[11] Additionally, open-ended questions are more statistically efficient, which makes it possible to reliably analyze more hypothesis with a smaller sample (Langford et al. 1998). Other studies that use open-ended questions include Brookshire et al. (1983) and Walsh et al. (1984). Mitchell and Carson (1989) argue that open-ended surveys will be acceptable in those cases where the respondents are familiar with the valued good and the payment mechanism. This was the case of coyotes in PEI. Given the expected sample size and the scope of the project, it was felt that the use of close-ended questions would compromise the analysis. It is also unlikely that PEI residents feel familiar with the idea of using a referendum to decide on the public funding of coyote control, which would be the preferred type of formulations for close-ended questions.

The econometric analyses were conducted taking into account the problem of item non-

Census of Population). Refer to the Appendix for an explanation of the scale (see variable *educat*).

[9] Efforts were made to try to randomly select the gender of the respondent. However, it is possible that a higher level of cooperation was obtained from male respondents.

[10] The text of the full questionnaire is available upon request.

[11] Loomis and White (1996), however, found using meta-analysis study that the choice of question format played a relatively minor role in estimates of WTP for endangered species.

response. Since some respondents refused to answer some of the questions, or interrupted the interview, some variables had missing values. Before running the regressions, these observations were removed. The final sample contained 143 observations. A summary of the variables involved in the survey can be found in Table 1. The Appendix contains also a list of definitions and descriptions of each variable.

4 Econometric Methodology

A persistent problem associated with the use of open-ended questions in contingent valuation studies is that often many respondents state a zero willingness to pay for the environmental change. This could be because those respondents do not positively value the change or because they lack the ability to pay any positive amount for it. Open-ended WTP distributions are often censored at zero because, since there is normally no possibility to state negative bid values, a large number of responses cluster around the value zero. Failing to recognize explicitly the censored or truncated distribution of bids in open-ended valuation surveys results in biased and inconsistent estimates. The Tobit regression (Tobin, 1958) where the true distribution of bid values is assumed to be truncated at zero has often been used to address this issue.

4.1 P-Tobit

The Tobit model only allows one type of zero observation, namely a *corner solution*, since it is based on the implicit assumption that zeros arise only as a result of the respondent's economic circumstances. This might be too restrictive when some individuals would never state a positive amount as a matter of principle (they consider, for example, that coyotes should be exterminated, not protected) or because they will be negatively affected by the provision of the good (farmers are likely to consider coyote protection a *bad*). The Tobit model can be made more flexible by considering these non-supporters of conservation.

First, the proportion of respondents who are potential supporters is assumed to be p, so that the proportion of respondents who would never support conservation is $(1 - p)$. For the former group, the Tobit model applies, while for the latter group, the stated level of support (henceforth denoted by Y) is automatically zero. This assumption leads to the P-Tobit model, originally proposed by Deaton and Irish (1984). The log likelihood function for the P-Tobit model is given by Expression 2 (Moffatt, 2003), whose maximization returns an estimate of p, in addition to those of β and σ, which the Tobit model returns.

$$LogL = \sum_{0} \ln\left[1 - p\Phi\left(\frac{\beta X_i'}{\sigma}\right)\right] + \sum_{+} \ln\left[p\frac{1}{\sigma}\phi\left(\frac{Y_i - \beta X_i'}{\sigma}\right)\right] \tag{2}$$

where $\Phi(\cdot)$ and $\phi(\cdot)$ refer to the standard normal probability and density functions, respectively.

4.2 The Double hurdle model

The P-Tobit model fails to analyze the factors that will make a respondent more or less likely to be a participant in the market (a supporter of coyote conservation). A further generalization allows for the parameter p to vary according to respondent's characteristics. This results in the Double-Hurdle model. Its underlying assumption in this setting is that individuals make two decisions with regard to their willingness to pay for coyote conservation. The first decision is whether they will state any positive amount at all at all. The second is about the amount they will state, conditional on the first decision. In the consumption literature these two decisions are whether to spend and how much to spend. The Double-Hurdle model allows for the possibility that these two decisions are affected by a different set of variables.

This model, originally due to Cragg (1971), has been extensively applied in a variety of areas. Applications include Burton, Dorsett and Young's (1996) and Newman (2001), who model household meat expenditure; Jensen and Yen (1996), who model US food expenditure away from home; Yen and Jones (1996 and 1997) who apply the model to alcohol consumption and US household consumption of cheese, respectively; Vredin-Johansson (1999), who analyzes charitable donations, and Moffatt (2003), who models loan defaults. The model has been rarely used in the area of conventional contingent valuation. Some exceptions would be Goodwin et al. (1993), Yen et al, (1997) and Reiser and Shechter (1999).

The Double-Hurdle model is a parametric generalization of the Tobit model, in which the decision to participate in the market (support coyote conservation) and the level of participation (stated amount for *tax*) are determined by two separate stochastic processes. The Double-Hurdle model has a *participation* (D) equation:

$$\begin{aligned} Di &= 1 \text{ if } D_i^* > 0 \text{ and } 0 \text{ if } D_i^* \leq 0 \\ D_i^* &= \alpha' Z_i + u_i \end{aligned} \tag{3}$$

being D^* a latent participation variable that takes the value 1 if the respondent supports the provision of the environmental good and 0 otherwise, Z a vector of household characteristics and α a vector of parameters; and a level of participation (Y) equation:

$$\begin{cases} Y_i = Y_i^* \text{ if } Y_i^* > 0 \text{ and } D_i^* > 0 \\ Y_i = 0 \text{ otherwise} \\ Y_i^* = \beta' X_i + v_i \end{cases} \tag{4}$$

where Y_i is the observed answer to the open-ended valuation question, X is a vector of the individual's characteristics and β a vector of parameters.

The decisions of whether to participate in the market and about the size of Y can be jointly modelled, if they are made simultaneously by the individual; independently, if they are made separately; or sequentially, if one decision is made first and affects the other one (this is the dominance model). If the *independence* model applies, the error terms are distributed as follows:

$$u_i \sim N(0, 1)$$
$$v_i \sim N(0, \sigma^2)$$

If both decisions are made jointly (the Dependent Double Hurdle) the error term can be defined as $(u_i v_i) \sim BVN(0, \Upsilon)$ where

$$\Upsilon = \begin{bmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{bmatrix}$$

The model is a *dependent model* if there is a relationship between the decision to support coyote conservation and the stated Y, given by:

$$\rho = \frac{cov(u_i v_i)}{\sqrt{var(u_i)var(v_i)}} \tag{5}$$

If $\rho = 0$ and there is dominance (the zeros are only associated to non-participation, not standard corner solutions) then the model decomposes into a Probit for participation and standard OLS for Y.

The error terms v_i and u_i in Equations 3 and 4 are usually assumed to be independently[12] and normally distributed. The latter assumption is not tenable in this application, so nonnormality will be further considered below (see Section 4.3.2). It was initially assumed that for each respondent the decision whether to participate in the market and the decision about the participation level were made independently. The validity of the assumption was tested formally (see Section 5.4).

The log-likelihood function for the double hurdle model is:

$$LogL = \sum_0 \ln \left[1 - \Phi(\alpha Z_i') \left(\frac{\beta X_i'}{\sigma}\right)\right] + \sum_+ \ln \left[\Phi(\alpha Z_i') \frac{1}{\sigma} \phi \left(\frac{Y_i - \beta X_i'}{\sigma}\right)\right] \tag{6}$$

Under the assumption of independency between the error terms v_i and u_i, the model (as originally proposed by Cragg, 1971) is equivalent to a combination of a truncated regression model and a univariate Probit model. The Tobit model, as presented above, arises if $\lambda = \frac{\beta}{\sigma}$ and $X = Z$. The parameters of the participation equation can be estimated independently using a truncated regression model.

A simple test for the Double-Hurdle model against the Tobit model can be used. It can be shown that the Tobit log-likelihood is the sum of the log-likelihoods of the truncated and the Probit models. Therefore, one simply has to estimate the truncated regression model, the Tobit model and the Probit model separately and use a likelihood ratio (LR) test. The $LR-$statistic can be computed using (Greene, 2000):

[12] See Smith (2003) for a formal theoretical analysis of why there might not be much gain from modelling dependence.

$$\Gamma = -2[\ln L_T - (\ln L_p + \ln L_{TR})] \sim \chi^2_k \tag{7}$$

where L_T = likelihood for the Tobit model; L_p = likelihood for the Probit model; L_{TR} = likelihood for the truncated regression model; and k is the number of independent variables in the equations. If the test hypothesis is written as $H_0 : \lambda = \frac{\beta}{\sigma}$ and $H_1 : \lambda \neq \frac{\beta}{\sigma}$. H_0 will be rejected on a prespecified significance level, if $\Gamma > \chi^2_k$.

4.3 Specification issues

4.3.1 Heteroskedasticity

The consistency of maximum likelihood estimates for this model depends on the assumptions of homoscedasticity and the normality of errors. Heteroskedascticity was suspected at the outset, since, depending on their county, respondents had different probabilities of having been sampled. As it is recommended in the case of survey analysis, weights were introduced so that the variance was allowed to vary according to each respondent's probability of having been sampled: $\widetilde{\sigma}^2_i = \sigma^2_i / prob_i$. Additionally, the maximum-likelihood specification was flexibilized further by modelling the transformed $\widetilde{\sigma}^2_i$ explicitly as a function of several variables. This is a commonly adopted solution in previous works (Jensen and Yen, 1996; Yen et al.1996; Yen and Huang, 1996; Angulo et al 2001).

4.3.2 Non-Normal Error Structure

A conditional moment test against the null of normal errors was conducted as performed by STATA 8.1 (Statacorp, 2003). The procedure implements a conditional moment test for testing the null hypothesis that the disturbances in the Tobit have a normal distribution. This test was derived by Pagan and Vella (1989), building on work by Newey (1985) and Tauchen (1985).[13]

[13] Skeels and Vella (1999) found that using the asymptotic distribution of this test produces severe size distortions, even in moderately large samples. Drukker (2002) suggested a parametric bootstrap to correct the size distortion and showed that even with the bootstrap critical values, the test still has reasonable power for samples greater than 500. This additional test was also conducted and, as described in Section 5.2, its results would cast doubt on the non-normality of the Tobit residuals. However, since the sample size is smaller than 500, the normality of the residuals was not relied upon.

The Double-Hurdle model relies on the assumption of normality of the errors u_i and v_i. If this assumption is not tenable, the ML estimates will be inconsistent. One way to accommodate the assumption of normality is by transforming the dependent and latent variables. The dependent variable Y was manipulated using a Box-Cox transformation (also used among others by Yen, 1993 Jones and Yen, 2000 and Moffatt, 2003).

$$Y^T = \frac{Y^\lambda - 1}{\lambda} \qquad\qquad 0 < \lambda < 1$$

Note that the Box-Cox transformation above includes as special cases a straightforward linear transformation ($\lambda = 1$), and the logarithmic transformation ($\lambda \to 0$), but normally we would expect the parameter λ to lie between these extremes.

The log-likelihood function for the independent Box-Cox double hurdle model is (Moffatt, 2003):

$$LogL = \sum_0 \ln\left[1 - \Phi(\alpha Z_i')\Phi\left(\frac{\beta X_i' + \frac{1}{\lambda}}{\sigma}\right)\right] + \sum_+ \ln\left[\Phi(\alpha Z_i')Y_i^{\lambda-1}\frac{1}{\sigma}\phi\left(\frac{Y_i^T - \beta X_i'}{\sigma}\right)\right] \tag{8}$$

This expression is similar to Expression 6 but the use of Y^T instead of Y in the final term requires a Jacobian term $Y^{\lambda-1}$ to be included (Moffatt, 2003).

4.4 Independence of errors

An alternative to the assumption of independence of errors would be to assume that the participation decision *dominates* the consumption decision. This would imply that no individual is observed at a standard corner solution, and that once the first hurdle is passed, standard Tobit censoring is no longer relevant, since no participant individual would have a zero as consumption level (Jones, 1989). All the zeros would be generated by the participation decision. In some contexts, the idea that participation in consumption dominates actual consumption is very appealing. For example, it is reasonable to assume that once an individual decides to smoke, for example, consumption takes place (Garcia and Labeaga, 1996). Therefore, there would be no *smokers* that consumed zero tobacco products. This model that assumes dependence and dominance (equivalent to a Heckman's generalized Tobit or sample selection model) could be decomposed into a Probit and a truncated regression. Complete dominance together with independency would result in a model that could be estimated as a Probit plus ordinary least squares.

The hypothesis of independence was tested and could not be rejected (see Section 5.4) Heckman's maximum likelihood and two-step approaches were investigated, too[14]. The latter confirmed that a model of first hurdle dominance was not appropriate in this case. That is, some potential supporters of coyote conservation exhibited corner solutions (stated a value of zero for *tax*). The next section describes the results of the econometric exercises employed to model *tax*.

5 Results

The mean value obtained for *tax* was $11.54.[15] In the following paragraphs the results of regressing the stated values of *tax* against a series of variables as explained in Section 2 are summarized. Further details can be found in the tables included in the Appendix. The variables used are also listed and described in the Appendix, and Table 1 includes summary statistics for the sample values. The regressions were analyzed using robust estimators to account for clustering within counties. The dependent variable (*tax*) was transformed beforehand into $Y = tax/10$. This transformation made possible a smoother and faster convergence of the most complex maximum likelihood regressions. There were some problems of multicollinearity between different variables whose suitability was tested as explanatory variables. This forced us to leave some *a priori* relevant variables out, such as sex of the respondent (*male*). However, the variables included in the final models show no serious problems of multicollinearity. If *educatsq* is excluded, the mean VIF for the variables in the Y equation is 1.12.

In limited dependent variable models, it is typically difficult to quantify the effects of explanatory variables on the dependent variable. This is particularly true for the models used in this paper, because the Double-Hurdle parametrization, the dependent error specification, and

[14] The results of these estimations are not reported but are available upon request.

[15] This mean was adjusted according to the STATA 8.1's survey handling procedures to account for the different probability of having been sampled according to the county of origin (STATA, 2003)

the Box-Cox transformation all complicate the effects of explanatory variables. Detailed quantitative effects of explanatory variables are usually omitted in applications of Double-Hurdle models. The main interest of this study is testing whether univariate of bivariate models are most appropriate to model the survey responses about tax. The focus lies on the main differences between the variables affecting the decision to participate in the conservation market and the variables affecting the choice of participation level, as well as the direction of the influence for the same variables. Since, as explained above, it is not possible to draw meaningful policy conclusions from the numerical results when a citizen perspective is considered, the actual values of the coefficients were of secondary importance. The calculation of marginal effects and elasticities from the maximum likelihood regressions was not attempted also because the consistency of this type of estimators is valid only for large samples.

5.1 Tobit model versus Double-Hurdle model

The first step of the analysis consisted of testing the Tobit model against the alternative of a Probit plus a Truncated (at zero) regression model. The Tobit model's results are reported in the first column of Table 2.[16] The other two columns show the results of using the same list of variables to explain separately the decision to support conservation (D) in the market for conservation (at least hypothetically) and the decision about to which extent to do so (Y). The result of the formal test, described in Section 5.3, between the Tobit and the two-step modelling (using a Probit plus a Truncated regression) favored the use of the double-hurdle model. The test statistic $\Gamma = 20.19$ exceeds the critical value ($\chi^2(9) = 16.92$) at the 5% level of significance. The less formal diagnostic of comparing the estimates β_{Probit} with β/σ_{Tobit} also showed that there is not a great deal of similarity between both. This suggests that the Tobit model would not be appropriate to explain why some respondents state a zero value for tax. It would yield incomplete and potentially misleading results about the influence of the different factors on the size of tax. The decision to state a positive value for tax and the decision about how much to state appear governed by different processes. However, it is noteworthy that only in the case of the *sheep* and *incometown* variables, the sign of the effect was different in each model.

[16] In all tables, p-values appear below each coefficient estimate.

[**TABLE 2 about here**]

5.2 Box-Cox Tobit and Box-Cox P-Tobit

A conditional moment test against the null of normal errors was conducted as performed by STATA 8.1 (Statacorp, 2003) as described in Section 4.3. The statistic 12.268 resulted in a Prob $> \chi^2 = 0.00217$, so the normality assumption was clearly rejected. This is not surprising since the variable *tax* was strongly skewed. Since the normality of the errors in the previous Tobit equation is questionable, the Box-Cox transformation was applied to the dependent variable ($tax/10$) before running a new (Box-Cox) Tobit. The Box-Cox P–Tobit results are also shown in the same table (Table 3). The Box-Cox Tobit nests the Tobit model and a likelihood-ratio test suggests that the Tobit model is too restrictive ($\chi^2(1) = 6.54$ so Prob $> \chi^2 = 0.011$). The corresponding tests of Box-Cox P-Tobit versus Tobit ($\chi^2(2) = 24.57$ so Prob $> \chi^2 = 0.011$) and Box-Cox P-Tobit versus Box-Cox Tobit ($\chi^2(1) = 18.04$ so Prob $> \chi^2 = 0.000$) show that it can be rejected that the less flexible models are not too restrictive.

Therefore, these two models dominate the Tobit, which they nest, but do not improve substantially the analysis. Note, in particular, the poor and anomalous performance of the P-Tobit, which suggests that modelling the proportion of no-participants as a fixed proportion is not a good idea. The estimate of p exceeds unity, contradicting the notion of probability and revealing that the first hurdle of the model is misspecified and that it is necessary to consider another source of censoring other than the restrictive ones available through the Tobit and P-Tobit specifications (Garcia and Labeaga, 1996; Maki and Nishiyama, 1996).

The next step involved allowing the probability of participating in the market (potentially stating a positive value for *tax*) to vary between respondents according to a series of characteristics.

[**TABLE 3 about here**]

5.3 Double hurdle versus Box-Cox Double Hurdle

Table 4 shows the results of the Double-Hurdle regression and the Box-Cox Double Hurdle. These results appear much more sensible. It can now be seen that there is a different set of variables behind the decision to state a positive willingness to contribute to the conservation of coyotes and the decision about how much to state as tax. However, although it can clearly be rejected that all the slope coefficients of the variables in the participation equation (D) are null, their individual significance is not overwhelming. The magnitude and sign of most of the coefficients are not different from those in the Tobit-like regressions above.

The Tobit-like models are nested in the double hurdle models, so likelihood-ratio tests used to formally investigate the differences between them.

The Double Hurdle is not radically different from the Tobit ($\chi^2(7) = 6.26$ so $Prob > \chi^2 = 0.509$) according to this test. Similarly, it cannot be rejected that Box-Cox Tobit is flexible enough, if compared with the Box-Cox Double Hurdle ($\chi^2(6) = 7.66$ so $Prob > \chi^2 = 0.264$), according to this test. This is even more evident in the case of comparisons involving the Box-Cox P-Tobit model which yields a log of pseudo-likelihood higher than the one for the Box-Cox Double Hurdle.

The objective of the paper was to find out whether it is important to analyze separately the decisions whether to reveal potential support for coyotes and, if so, how strongly. At this stage, it is unclear that the explicit modelling of these two separate decisions is necessary. However, some specification issues might remain unsolved at this point, and these are dealt with in the next subsection.

[Table 4 about here]

5.4 Accounting for heteroskedasticity and testing the assumption of independence of errors

The previous models considered the possibility that errors were not independent within counties by calculating robust standard errors corrected to account for this clustering. However, they did not take into account that those observations coming from more populated counties might be more reliable than others for which the probability of an individual's being selected is higher. This is why the Double Hurdle and Box-Cox Double Hurdle were modified by weighting the variance according to each respondent's probability of having been sampled. Additionally, the maximum-likelihood specification was flexibilized further by modelling the transformed $\widetilde{\sigma}_i^2$ explicitly as a function of several variables. In particular, *educat*, *educatsq*, *income*, *density* and *hunt* proved to significantly affect the variance. The results are shown in Table 5.

The Double Hurdle corrected for heteroskedasticity nest the uncorrected ones. The likelihood-ratio tests clearly show that the models that account for heteroskedasticity are significantly more appropriate than the previous ones. ($\chi^2(4) = 82.31$ for the Double-Hurdle models, and $\chi^2(5) = 78.22$,in the Box-Cox transformed cases, both with $Prob > \chi^2 = 0.000$). The test also favors the double hurdle specification over the P-Tobit one.[17]

[Table 5 about here]

The results of these most flexible models reveal that the process generating a zero response and the process behind the size of *tax* are different. This is in line with the expectation that some of the respondents considered coyotes a public bad, while others considered them a public good. While the former should be expected to always, as a matter of principle, state a zero response regardless of their circumstances, the latter should be expected to state variable amounts depending on their socioeconomic characteristics. The objective of the paper was to find out whether it is important to analyze separately these two processes. It can be seen now that a different set of variables govern each process. The coefficients of the variables that are common to both sets often present opposite signs, apart from different sizes. The actual size of the estimates and the marginal effects of changes in each variable are of secondary importance. It is interesting, however, to comment on how the different variables considered work within each process.

The effect of *age* on participation (D) is U-shaped and highly significant in the Box-Cox Double-Hurdle, suggesting that respondents around thirty-nine ($\frac{-(-0.720933)}{0.009258\cdot 2} = 38.936$) years of age would be the least likely to state a positive amount for coyote protection through *tax*. This could be explained by the fact that these respondents exhibit the least favorable attitude towards coyotes and also perhaps a negative attitude towards the use of general taxation to support their conservation through compensations to farmers. The age variable affects the

[17] $\chi^2(10) = 64.00$ for the Double-Hurdle and $\chi^2(11) = 67.85$ for the Box-Cox Double Hurdle, resulting in $Prob > \chi^2 = 0.000$ in both cases.

choice of *tax* differently, with a negative sign on *agesq* and a nonlinearly increasing effect.

In the case of the *tax* model the education level of the respondent exhibits an inverted-U shape, suggesting that as education levels approach college degrees, stated *tax* diminishes (for $educat = \frac{-(2.603963)}{-0.697554 \cdot 2} = 1.866$). In the participation model, the regular-U shape suggests that the negative effect of age on the likelihood of participation bottoms out for a level of education $educat = \frac{-(-2.706280)}{0.591999 \cdot 2} = 2.285$) slightly higher than the level at which the expected size of *tax* is maximum.

The variable *income* shows an effect with opposite signs in each model but is only statistically significant in the case of Y, not in the case of participation (D). Those living in more urban areas appear to support less taxes for coyote conservation, but, given the other variables, the effect is not statistically significant. This is not surprising in a study that asks respondents about their judgement of how much everyone should contribute to conservation, instead of asking how much they would individually pay. That is, the answer has more to do with the expression of a preference than with the combination of a preference and an individual ability to pay.

Respondents who declared to *hunt* stated support for significantly lower levels of *tax* to help protect coyotes than non-hunters. However, hunters are much less likely to state a zero amount for *tax*. There is a significantly positive effect of the *incometown* variable, probably reflecting that those in richer counties are richer, tend to live in more urbanized areas, and probably have more favorable attitudes towards coyotes. Again, this reflects that it is the individual perception of how much everyone can afford to pay, rather than the individual ability to pay what drives the size of the stated value under a *citizen* perspective. This would not be expected to apply to the case of a consumer perspective.

The effect of *sheep* ownership is also highly significant and positive. Sheep farmers in Prince Edward Island should be against coyote conservation. However, they are usually disappointed with lethal methods for dealing with coyote predation and would of course be wiling to support high levels of general taxation earmarked to compensate them for losses to predation.

The hypothesis of independence between the error terms in the participation equation and the *tax* equation could not be rejected. When testing null hypothesis ($\rho = 0$ in Equation 5) in the Double-Hurdle model the Wald-statistic took the value of $\chi^2(1) = 0.05$ resulted in a Prob>χ^2

= 0.8298, while in the case of the Box-Cox Double Hurdle the statistic value of $\chi^2(1) = 2.29$ resulted in a Prob > $\chi^2 = 0.1302$. These values allow to place some confidence on the validity of the assumption of independence.

The best model overall appears to be the most flexible one. This allows for a different set of variables to affect the decision whether to support the policy and the choice on the level of that support. It accounts for the survey nature of the data, the different population sizes of the different counties where the respondent live (through *prob*) and considers a Box-Cox transformation of the dependent variable ($tax/10$), which accounts for the non-normal distribution of residuals resulting from the use of the untransformed variable. The final model clearly outperforms the rest in terms of the *AIC* criterion, the Wald χ^2 and the plausibility of the results.

The sample size did not make it possible to introduce some variables in the model that might add interesting economic insight. Variables such as *male*, *coyote*, *lastseen*, *problems*, *cats*, *dogs* were considered in different models, but the constraints imposed by the need to achieve convergence of the maximum likelihood regressions and the problems of multicollinearity prevented them from appearing in the finally reported model.

6 Conclusions and suggestions for further research

The results show that some PEI residents would be willing to support an increase in general taxes to protect coyotes. However, the degree of support to this conservation policy depends on their socioeconomic status, their age, their county of residence, and certain attitudes towards wildlife.

The main aim of the paper was to investigate the drivers explaining the responses of individuals to a valuation question framed within a citizen, rather than a consumer perspective. As expected, the effect of most variables on the stated socially acceptable increase in taxes goes in the same direction as the one they would be expected to have on the conventional willingness to pay. One unsurprising exception is the case of household income.

The second main objective of the paper was to evaluate the usefulness of the double-hurdle specification in the context of wildlife valuation. The results stress the importance of modelling separately the decision on whether to support an environmental cause and the decision about how much to contribute to that cause. This is particularly important when considering species that sectors of the public consider public bads rather than public goods. Many of the zero responses obtained are not simple corner solutions. They have more to do with the fact that the respondent is not willing to support the protection of the species regardless of circumstances that might affect the the degree of support if she was in principle willing to support that protection. The Eastern coyote is one clear example of this type of species. The same analysis could be applied to similar cases, such as wolves, bears, or Canada geese.

It is not possible to derive meaningful policy implications from this type of analysis in isolation. Given the way in which the valuation scenario was presented, it is possible that some of the respondents were not expressing how much they care about coyotes themselves, but rather how much they cared about coyotes being controlled. That is, they expressed through their responses not their social preference to preserve coyotes, but rather their dislike of killing coyotes because they affect sheep farming.

In the same sense, it is not easy to discern to which extent the respondents are expressing support for coyote conservation or support for compensation to affected farmers. The valuation scenario gained realism with the introduction of the idea of compensation, but this also complicated the interpretation of the results within a cost-benefit analysis setting (as explained by Diamond and Hausman, 1994).

The analysis presented in this paper was also limited in terms of sample size. The use of open-ended questions was forced in the first place by the size of the sample and the limitations of the data collection process. It would be interesting to employ close-ended questions and compare the results with those above.

Adopting a citizen perspective when responding to the valuation question implies that the respondent is expressing a judgement about the instrumental value derived from the resource, the perceived fairness of the payment vehicle and the proposed policy scheme, the perceived impact on himself or herself and also on the impact of others of that proposed policy, as well as a judgement about what society should sacrifice to preserve the resource. In summary, the type of responses obtained in this study do not correspond to the individual's valuations of the good, which could be aggregated to estimate the total value. However, they could be used to estimate what citizens think the government should consider when making decisions about coyote conservation. The type of approach employed here might be useful to predict how the public would respond to conservation policies involving governmental intervention and to complement the insights obtained through conventional valuation exercises. Although the *Homo Economicus* was not interrogated in this occasion about willingness to pay, the opinion of the *Homo Politicus* about a socially acceptable payment and the way in which this payment appears to be affected by certain variables could inform management policies that consider not only efficiency issues, but also subjective concerns about the fairness of the decision-making process, the distribution of gains and losses, the intrinsic value of wildlife species, and cultural and social values. This type of approach is most relevant in cases in which the policy concerned generates a number of clear losers and a variety of diffuse winners (including future generations), the resource is nonrival, there is no experience nor realistic expectation of individual payments towards the conservation of the resource, non-use values, such us existence values, take up a potential large component of the value, and when the management of the resource entails actions, such as coyote trapping, that could be seen as controversial. In sum, this approach is more appropriate for situations that have to do more with individuals' political views than with their consumer interests, for decisions that require individuals to judge more than their own individual welfare..

This is, to the author's knowledge, the first time that this type of analysis has been conducted. One obvious extension would be the comparison of the values obtained under a citizen-like approach and under a consumer-like approach for two different samples of the same population. It is likely that depending on the type of good, the estimated social value is sometimes underestimated and sometimes overestimated by the purely economic value obtained through conventional contingent valuation.

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Appendix: Variables description.

Note that some of these where considered but removed from the finally reported models.

D (binary variable: 1 if *tax*>0 and 0 otherwise)

density (population density in the county according to STATS CANADA)

incometown (average annual income in the county according to STATS CANADA)

age age of the respondent

male binary variable regarding sex of the respondent

educat education level (ordered dummies from 1= less than high school, 2= high school; 3 = some college to 4 = college degree)

livestock binary=1 if respondent has any livestock

sheep binary=1 if respondent has any sheep

cats binary=1 if respondent has any cats

dogs binary=1 if respondent has any dogs

hunt binary=1 if respondent hunts

coyote binary=1 if respondent ever saw a coyote in PEI

lastseen when the respondent saw the coyote last 1 = never 2, 3, 4, 5, 6 = very recently

problems binary=1 if respondent ever had trouble with coyotes in PEI

neighbours binary=1 if respondent ever heard about trouble with coyotes in PEI

tax amount considered reasonable for a tax imposed on all PEI residents to fund a program that compensated farmers for the livestock lost to coyotes

income household gross income categories, mean points of interval used ($25000, $35000, $45000, and $55000)

*pop*2001 population in the county according to STATS Canada

Prob pop2001/number of observations per county

$Y = tax/10$

Y^T (Box-Cox transformed $tax/10$)

Variable	Obs	Survey-corrected Mean	Mean	Std. Dev.	Min	Max
age	143	41.34337	43.81818	17.25845	12	82
educat	143	2.641994	2.559441	0.983114	1	4
income	143	38703.63	38566.43	12356.53	25000	55000
density	143	109.2227	179.8637	261.6321	6.06264	923.1068
hunt	143	0.047765	0.1188811	0.324786	0	1
incometown	143	19876.4	18791.64	3081.899	1782	24213
sheep	143	0.011758	0.013986	0.117845	0	1
tax	143	11.5358	10.32168	18.59572	0	100
prob	143	8162.111	1065.099	2759.031	39	19452.67
D	143	0.567482	0.4825175	0.501451	0	1

Table 1: Sample summary statistics

Variable	Tobit	Probit	Truncated
Dependent	Y	D	Y(|Y>0)
agesq	-0.0007956	-0.0003237	-0.0036505
	0.000	0.000	0.288
educat	1.600814	0.2925457	24.27679
	0.323	0.646	0.514
educatsq	-0.36041	-0.1036454	-3.705436
	0.244	0.378	0.579
income	.0000313	0.0000086	.0004148
	0.220	0.328	0.419
density	0.0015031	0.0006634	.0013881
	0.153	0.055	0.813
hunt	-1.674013	-0.6419249	-5.55173
	0.089	0.037	0.716
incometown	0.0001514	0.0000919	-0.0009164
	0.142	0.046	0.513
sheep	-0.1720902	0.2416379	-55.55016
	0.941	0.840	0.367
constant	-4.175787	-1.421028	-53.01638
	0.150	0.203	0.517
σ	2.877287		7.703442
	(ancillary)		0.079
$\chi^2(8)$	LR =27.13	Wald=59.99	
	0.0007	0.0000	
Pseudo R-sq		0.1473	
$LOG-L$	-212.07931	-84.442223	-117.53976
AIC(-LOG-L+k/n)	1.539016154	0.534561	0.7660123
χ^2-Test Double Hurdle versus Tobit: Γ =20.19>$\chi^2(9)$=16.92;			
CM(H_0 of normally distributed errors)= 12.268 Prob > χ^2=0.00217			

Table 2: Tobit versus Probit and Truncated regression

Variable Dependent	Box-Cox Tobit Y^T	Box-Cox P-Tobit Y^T
agesq	-0.0007188	-0.0007836
	0.000	0.001
educat	1.298503	-0.0458444
	0.292	0.965
educatsq	-0.3065112	-0.1415603
	0.198	0.427
income	0.0000258	0.0000564
	0.204	0.043
density	0.0013342	0.0025132
	0.002	0.003
hunt	-1.492176	1.229249
	0.008	0.056
incometown	-0.0001542	0.0002381
	0.011	0.021
sheep	-0.0466311	-0.6570066
	0.984	0.709
constant	-4.843946	-71.37977
	0.012	0.000
σ	2.507159	12.36435
	0.0000	0.000
λ	0.7942947	0.000000103
	0.0000	0.220
p		1.075525
		0.000
Wald $\chi^2(8)$	68.46	16.42
	0.0000	0.0367
$LOG-L$	-208.80975	-199.84562
AIC(-LOG-L+k/n)	1.404263986	-1.341577762

Table 3: Box-Cox Tobit versus Box-Cox P-Tobit

Variable	Double Hurdle		Box-Cox Double Hurdle	
Dependent	Y	D	Y^T	D
age		-0.2102686		-0.3038477
		0.662		0.273
agesq	-0.0006438	0.0011977	-0.0005384	0.0026789
	0.000	0.791	0.000	0.310
educat	1.9712571	-23.71698	2.1852670	-5.43576
	0.240	0.000	0.095	0.170
educatsq	-0.4045376	3.4836924	-0.4533813	0.8933262
	0.230	0.000	0.075	0.117
income	0.0000556	-0.0001705	0.0000550	-0.0000566
	0.016	0.013	0.035	0.027
density	0.0013346		0.0010182	
	0.030		0.090	
hunt	-2.047377	5.2415280	-2.003132	0.7040805
	0.002	0.000	0.001	0.000
incometown	0.0001449		0.0001389	
	0.055		0.023	
sheep	1.3502976		1.9002575	
	0.457		0.024	
constant	-5.529864	56.056543	-6.635814	19.094727
	0.020	0.000	0.001	0.003
σ	2.7465686		2.2338070	
	0.000		0.000	
λ			0.758316	
			0.000	
Wald $\chi^2(8)$	53.32		66.24	
	0.0000		0.0000	
$LOG - L$	-208.94724		-204.98158	
AIC(-LOG-L+k/n)	1.5171135		1.4893817	

Table 4: Double-Hurdle versus Box-Cox Double Hurdle

Variable	Double Hurdle			Box-Cox Double Hurdle		
Dependent	Y	D	σ	Y^T	D	σ
age		-0.719278			-0.720933	
		0.017			0.021	
agesq	-0.0006701	0.009289		-0.0006216	0.009258	
	0.000	0.009		0.000	0.013	
educat	2.9208886	-2.686611	-2.474401	2.6039633	-2.706280	-2.139687
	0.000	0.082	0.026	0.001	0.077	0.029
educatsq	-0.7835407	0.595458	0.774878	-0.6975537	0.591999	0.662555
	0.999	0.053	0.003	0.056	0.055	0.004
income	-0.0000361	0.000006	0.000007	-0.0000313	0.000008	0.000007
	0.009	0.869	0.061	0.004	0.834	0.001
density	-0.0001640		0.002178	-0.0003215		0.001951
	0.896		0.025	0.793		0.010
hunt	-2.238339	5.344543	2.188951	-2.148186	5.384226	1.904007
	0.000	0.000	0.026	0.000	0.000	0.026
incometown	0.0001186			0.0001157		
	0.000			0.000		
sheep	5.5291641			5.0929122		
	0.000			0.000		
constant	-0.7595202	15.850587		-1.770602	15.924159	
	0.502	0.017		0.103	0.020	
λ					0.830860	
					0.000	
Wald $\chi^2(8)$		4750.84			3067.31	
		0.000			0.000	
$LOG-L$		-167.7904749			-165.8681519	
AIC(-LOG-L+k/n)		1.22930402			1.215861202	

Table 5: Double-Hurdle versus Box-Cox Double-Hurdle accounting for heteroskedasticity