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An Econometric Analysis of Donations for Environmental Conservation in Canada

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As provincial governments in Canada trim budgets, fewer funds are available for environmental conservation programs. Many jurisdictions are letting private interests and/or users of the resource base help fund conservation projects. Thus funding for conservation is becoming more dependent on donations to environmental causes either through direct giving of funds or through memberships in organizations. This study explores some determinants of private contributions to environmental conservation activities through an econometric analysis of donations and memberships relating to wildlife habitat protection and enhancement. We use data from a 1991 survey conducted in the three prairie provinces that provides information on donation behavior, income, wildlife-related activity, household compositions, and a variety of other factors. A double-hurdle econometric model is used to allow independent variables to have different effects on the probability of donations and the level of donations. Our empirical results suggest that changes in the economy will be important to donation behavior. Declines in participation and recruitment in hunting will also have impacts on donations to conservation causes, but these impacts, although significant, may not be as large. However, consumptive and nonconsumptive activities may be influenced by management agencies and used to bolster environmental donations.

Key words: conservation, donations, double-hurdle, environment, inverse hyperbolic sine transformation, limited dependent variable, nonparticipation, wildlife

Introduction

Environmental protection in Canada has traditionally been funded from general tax revenues. Fish and wildlife habitat enhancement and endangered species protection are prominent examples. In the past few years, however, provincial governments have trimmed budgets resulting in fewer funds available for environmental conservation programs. In response, many jurisdictions now seek to have private interests and/or users of the resource base help fund these programs. Examples include the North American Waterfowl Management Program, land purchases by The Nature Conservancy, the Buck-for Wildlife project (in Alberta), and various other public-private joint ventures (Porter and van Kooten). In many of these programs the private funds come from memberships or donations to private organizations (e.g., The Nature Conservancy, Ducks Unlimited). Thus, funding for conservation is becoming more dependent on donations to environmental organizations either through direct gifts or through memberships.

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Another concern is that numbers of traditional supporters of wildlife habitat management (recreational hunters and anglers) are decreasing (e.g., Boxall, Duwors, and Filion). Traditionally, these supporters were responsible for funding of much of wildlife habitat conservation programs either through license sales, special checkoffs that accompany license sales, or through membership fees and donations to fishing- and hunting-related organizations. For example, Ducks Unlimited and Trout Unlimited began as hunting and angling organizations, respectively, and much of their funding has been based on contributions from hunters and anglers. With the number of hunters in Canada declining 17% over the last 10 years (Filion et al.), and anglers also declining over the same period (e.g., 26% in Alberta), will this traditional funding base remain?

This article explores some determinants of private contributions to environmental conservation activities through an econometric analysis of donations and memberships relating to wildlife habitat protection and enhancement.[1] We are interested in the factors affecting donations in part because we wish to determine if continuing declines in the number of hunters and anglers will affect the level of donations to conservation activities. We are also interested in understanding the relationships between income, marginal tax rates (the price of donations), and other variables on the inclination to donate. Given the increasing importance of private funding of wildlife programs, knowledge of these relationships will be important for public and private agencies involved in wildlife conservation.

We use data from a 1991 survey conducted in the three prairie provinces that provide information on donations, income, wildlife-related activity, household compositions, and a variety of other factors. The methods must consider that most individuals do not donate to wildlife causes. Each individual essentially faces two decisions—a decision of whether to donate or not and a decision on how much to donate, conditional on deciding to donate. Our econometric analysis incorporates the two-level decision structure and the possibility of correlation between the two decision processes. We also use the model to forecast donations under conditions of falling hunter recruitment rates.

Previous research on wildlife donations has examined after tax checkoffs in the U.S.[2] These studies suggest that knowledge of wildlife or participation in wildlife-related activity are important explanators of involvement in the checkoffs (Applegate 1984; Brown, Connelly, and Decker; Manfredo and Haight; Harris, Miller, and Reese). However, these results are not directly comparable with ours since they do not examine all donations to wildlife organizations and since tax checkoff programs are not currently used in Canada. The U.S. studies have also not considered the joint decision to donate and the amount of donation. Our analysis more closely parallels the type of research performed on general donations.

Kitchen and Kitchen and Dalton examine donations in Canada. These authors indicate that income, marginal tax rates (effectively the price of donations), and region within Canada affect donations. Also, factors affecting religious donations appear to be different from the factors affecting other types of donations. These authors use a tobit model

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[1] We refer to monies spent on memberships in wildlife conservation organizations as well as gifts to these organizations as donations, even though in the case of memberships a product is being purchased. The membership funds are typically targeted to support wildlife enhancement programs, and thus, we assume they are effectively donations to wildlife-related causes.

[2] In many states, individuals are given the opportunity to give a part of their tax refund to wildlife conservation programs by writing an amount on their tax forms.

framework to take into account the limited dependent variable nature of the data. The tobit model assumes that the decision to donate or not and the decision on the magnitude of the donation are affected by the same parameters on the same variables. In our analysis we relax this assumption and use a double-hurdle model to allow the effects of independent variables to be different in the participation and level portions of the donation equations. We also provide for flexibility in functional form by using an inverse hyperbolic sine transformation. These models, and a more formal presentation of the theoretical underpinnings of the situation, are described below.

The Model

Following the literature on charitable giving, an individual is assumed to choose the level of donation, along with the levels of other consumer goods, that maximize utility subject to a budget constraint. Donations are considered to generate utility and thus they are included as arguments of the utility function. Donation amounts in dollars are included in the utility function since these are assumed to be the item generating utility.[3] Since donations are tax deductible their price can be calculated as $p = 1 - t$, where t is marginal tax rate (Jones and Posnett 1991b). Thus, the optimal level of donation can be derived by solving the constrained utility maximization problem:

$$(1) \qquad \max_{d,c} \, [u(d, c, h) \,|\, pd + q'c = m],$$

where d is donations with price p, c is a vector of other consumer goods with price vector q, h is a vector of personal characteristics, and m is the budget. Assuming the utility function $u(\cdot)$ is continuous, increasing, and quasi-concave, then the optimal donation level can be expressed as a function of prices, income, and personal characteristics. Denote the vector of these determinants as $x = [p,q',m,h']'$, and assume a linear functional form as an approximation to the "true" form of the donation equation. Then, for individual i, the optimal donation d_i^* can be written as:

$$(2) \qquad d_i^* = x_i'\beta + \epsilon_i,$$

where β is a vector of parameters and ϵ_i is random error. The demand equation (2) represents the "notional" or "latent" demand for donations and is the result of utility maximization without a nonnegativity constraint. In reality, an individual's choices are also subject to nonnegativity constraints, and corner solutions result when the notional demand is negative. One econometric model that captures this structure is the tobit model (Tobin). The tobit model has been used in previous studies of donations in Canada (Kitchen; Kitchen and Dalton), in the U.S. (Brown; Lankford and Wyckoff; Reece; Reece and Zieschang 1985, 1989; Schiff), and in the U.K. (Jones and Posnett 1991a).[4]

In most economic analyses, using the tobit model implies that an interior solution would occur if the price is sufficiently low. This may not apply in the case of donations, as there are individuals who never donate regardless of price and income. Such "non-

[3] There are other conceptual approaches that could be used to model the choice of donations to environmental causes. For example, the environmental good could be included in the utility function and the donation only appear in the budget constraint. However, we follow the approach employed in the general literature on charitable giving.

[4] Lankford and Wyckoff generalize the tobit model by using the Box-Cox transformation on the error terms.

participation" decisions should be considered. One model that accommodates both nonparticipation and nonconsumption is the double-hurdle model (Atkinson, Goumulka, and Stern; Blundell and Meghir; Cragg).[5] In the double-hurdle model, the consumption equation (2) is augmented with a participation equation for the binary outcome:

$$w_i^* = z_i'\alpha + v_i, \tag{3}$$

where w_i^* is a latent (unobservable) participation variable, z_i is a vector of exogenous variables, α is a conformable parameter vector, and v_i is random error. The double-hurdle model has typically been estimated with bivariate normal or separate univariate normal specifications for the errors v_i and ϵ_i. However, maximum-likelihood (ML) estimates are inconsistent when the normality assumption is violated (Robinson). We accommodate nonnormal errors with a transformation on the dependent variable. Therefore, the double-hurdle model we consider can be written as:

$$d_i^T = \begin{cases} x_i'\beta + \epsilon_i & \text{if } z_i'\alpha + v_i > 0 \text{ and } x_i'\beta + \epsilon_i > 0, \\ 0 & \text{otherwise,} \end{cases} \tag{4}$$

where d_i^T is a transformation of the dependent variable d_i. Without the transformation of the dependent variable the model (4) corresponds to that of Atkinson, Gomulka, and Stern and Cragg. This model addresses the issue of corner solutions using a continuous hurdle model approach. The first hurdle ($z_i'\alpha + v_i > 0$) accommodates zeros for those who would never donate under any circumstances, and the second hurdle ($x_i'\beta + \epsilon_i > 0$) accommodates zero for potential donators whose zero donations are results of economic decisions, that is, corner solutions. Thus, for positive donations to occur, two hurdles have to be overcome: to be a potential donator and to actually donate. Following Yen and Jones (1997), we consider the inverse hyperbolic sine transformation of the dependent variable (Burbidge, Magee, and Robb):[6]

$$d_i^T = \sinh^{-1}(\theta d_i)/\theta = \log[\theta d_i + (\theta^2 d_i^2 + 1)^{1/2}]/\theta, \tag{5}$$

where θ is a scalar parameter. Because the transformed variable is symmetric about zero, one can only consider $\theta \geq 0$. The transformation is linear when θ approaches zero and behaves logarithmically for large values of d_i for a wide range of values for θ. The transformation is scale invariant (MacKinnon and Magee) and is known to be well suited for handling extreme values of the dependent variable (Burbidge, Magee, and Robb). Assume the random errors $[v_i, \epsilon_i]'$ are distributed as bivariate normal:[7]

$$\begin{pmatrix} v_i \\ \epsilon_i \end{pmatrix} \sim N\left(0, \begin{bmatrix} 1 & \sigma_{12} \\ \sigma_{12} & \sigma^2 \end{bmatrix}\right), \tag{6}$$

and express the correlation coefficient as $\rho = \sigma_{12}/\sigma$. Then the sample likelihood function is

[5] In an analysis of charitable donations by U.K. households, Jones and Posnett (1991b) use the generalized (type II) tobit model (Amemiya, p. 385), in which zeros are determined exclusively by a binary stochastic process, that is, $d_i = x_i'\beta + \epsilon_i$ if $z_i'\alpha + v_i > 0$; $d_i = 0$ otherwise, where the error terms v_i and ϵ_i are distributed as bivariate normal. Specification of the generalized tobit model differs slightly from that proposed by Cragg [(7) and (9)], in which v_i and ϵ_i are independent and ϵ_i is zero-truncated normal. An application of Cragg's model (with the inverse hyperbolic sine transformation) is seen in Yen and Huang.

[6] Yen and Jones (1996) apply the Box-Cox transformation to the double-hurdle model.

[7] Similar to other binary-choice models, the unitary variance of v_i is needed for identification.

$$(7)\qquad L = \prod_{d_i=0}\left[1 - \Psi\left(z_i'\alpha, \frac{x_i'\beta}{\sigma}, \rho\right)\right] \times \prod_{d_i>0}\left\{(1 + \theta^2 y_i^2)^{-1/2}\frac{1}{\sigma}\phi\left(\frac{d_i^T - x_i'\beta}{\sigma}\right)\Phi\left[\frac{z_i'\alpha + \rho(d_i^T - x_i'\beta)/\sigma}{\sqrt{1-\rho^2}}\right]\right\},$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the univariate standard normal p.d.f. and c.d.f., respectively, and $\Psi(\cdot,\cdot,\cdot)$ is the bivariate standard normal c.d.f. Detailed derivation of the likelihood function is available from the authors. Estimation was carried out with the quadratic hill-climbing algorithm (Goldfeld, Quandt, and Trotter) in GQOPT6, with log-likelihood function, analytic derivatives of the log-likelihood function, and BHHH Hessian programmed in FORTRAN.[8]

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 considered in this study because the double-hurdle parameterization, the dependent error specification, the IHS transformation, and the conflicting effects of variables on the participation and level decisions, all complicate the effects of explanatory variables. In fact, detailed quantitative effects (conditional and unconditional marginal effects) of explanatory variables have often been overlooked in previous applications of double-hurdle models. In this study, we examine the probability of participation in donation and the mean donation conditional and unconditional on participation and examine the effects of variables on these components.[9] The conditional mean of the dependent variable d_i is

$$(8)\qquad E(d_i|d_i > 0) = \left[\Psi\left(z_i'\alpha, \frac{x_i'\beta}{\sigma}, \rho\right)\right]^{-1} \times \int_0^\infty d_i(1 + \theta^2 d_i^2)^{1/2}\frac{1}{\sigma}\phi\left(\frac{d_i^T - x_i\beta}{\sigma}\right)\Phi\left[\frac{z_i'\alpha + \rho(d_i^T - x_i'\beta)/\sigma}{\sqrt{1-\rho^2}}\right]dd_i.$$

The probability of a positive observation, $P(d_i > 0)$, is the bivariate normal probability in (8). Then, the unconditional mean of d_i is

$$(9)\qquad E(d_i) = P(d_i > 0)E(d_i|d_i > 0),$$

which is just the conditional mean with the inverse of the bivariate normal probability canceled out. The elasticities of the probability, conditional mean, and unconditional mean can be derived by differentiating these components with respect to the explanatory variables. Note that the elasticity of probability differs from the coefficient on the participation equation as the former reflects the change in the probability (passing both hurdles) while the latter examines the impact on the first hurdle alone.

The elasticities with respect to continuous variables are calculated at the sample means of variables. For statistical inferences, the standard errors of these elasticities are derived by first-order Taylor series approximation using the variance-covariance matrix of the parameter estimates (e.g., Fuller, pp. 85–88).

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[8] Analytic derivatives of the log-likelihood function are available from the authors.

[9] Our procedure is similar to that of McDonald and Moffitt, who examine the effects of explanatory variables for the tobit model.

Table 1. Definitions of Variables Used to Examine Donations to Wildlife Conservation in Three Provinces in Canada from the 1991 National Survey on the Importance of Wildlife to Canadians

Variable	Definition
Donation	Amount spent on membership fee(s) or donation(s) during 1991; dependent variable
Income	Personal income before deduction (1 = 0; 2 = less than $5,000; 3 = $5,000–9,999; 4 = $10,000–19,999; 5 = $20,000–29,999; 6 = $30,000–39,999; 7 = $40,000–49,999; 8 = $50,000 or more)
Education	Level of education (1 = 0–8 years; 6 = university degree)
Age group	Age group (1 = 15–16 years; 13 = 70 years or over)
Rural	Resides in a rural community with less than 10,000 people (dummy variable where 1 = yes; 0 = no)
Male	Individual is male (dummy variable where 1 = yes; 0 = no)
Head	Individual is a head of household (dummy variable where 1 = yes; 0 = no)
Abundance	Index of importance of abundance of wildlife[a]
Preserving	Importance of preserving declining or endangered wildlife (0 = not important; 3 = very important)
Some interest	At least some interest in studying/watching wildlife, etc. (dummy variable where 1 = yes; 0 = no)[b]
Fishing interest	At least some interest in fishing (dummy variable where 1 = yes; 0 = no)
Days residence	Number of days spent on wildlife activities around residence or cottage in 1991 (1 = 1 to 9 days; 7 = 200 days or more)
Days in province	Number of days spent on trips inside province of residence in 1991 where the primary purpose of the trip was to encounter wildlife (watching, feeding, photographing, or studying wildlife)
Days outside prov.	Number of days spent on trips outside province of residence in 1991 where the primary purpose of the trip was to encounter wildlife (watching, feeding, photographing, or studying wildlife)
Days incidental	Number of days spent on trips in Canada in 1991 where wildlife was observed, but the main purpose of the outings was other than encountering wildlife (e.g., hiking/picnics) (1 = 1–9 days; 7 = 200+ days)
Hunter	Ever hunted wildlife (dummy variable where 1 = yes; 0 = no)
Total expenditures	Total expenditures on fish and wildlife activities in $100 (imputed)
Tax price	Tax price (calculated as 1 − estimated marginal tax rate)
Alberta	Resides in Alberta (dummy variable where 1 = yes; 0 = no)
Manitoba	Resides in Manitoba (dummy variable where 1 = yes; 0 = no)

[a] Derived as the sum of scores indicating importance for abundance of waterfowl, other birds, small mammals, and large mammals, each with a value ranging from 0 (not important) to 3 (very important).
[b] Activities include watching, photographing, studying, feeding, hunting, and trapping wildlife; collecting specimens; and observing, collecting, creating wildlife-related art/literature.

The Data

Data from the 1991 National Survey on the Importance of Wildlife to Canadians (NSIWC) for the three prairie provinces (Alberta, Saskatchewan, and Manitoba) were used here. The 1991 survey is one of three completed under the sponsorship of federal and provincial wildlife agencies (Filion et al.) and was conducted as a supplement to the Canadian Labour Force Survey (LFS) which is administered by Statistics Canada on an ongoing basis (Statistics Canada). The LFS is a monthly household survey whose sample is representative of the civilian noninstitutionalized population over 15 years of age. The

Table 2. Summary Statistics for Variables Used in the Analysis of Donations to Wildlife Conservation

Variable	Low Income		Medium Income	
	Mean	SD	Mean	SD
Donation	2.61	18.00	7.24	61.76
	(47.82)[a]	(61.55)[a]	(69.94)[a]	(180.40)[a]
Income	2.109	0.772	4.451	0.498
Education	2.883	1.422	3.478	1.517
Age group	6.048	3.892	7.083	3.202
Rural[b]	0.515		0.448	
Male[b]	0.302		0.482	
Head[b]	0.264		0.571	
Abundance	8.761	3.875	9.351	3.512
Preserving	2.220	1.002	2.352	0.899
Some interest[b]	0.769		0.805	
Fishing interest[b]	0.525		0.602	
Days residence	2.036	2.237	2.255	2.276
Days in province	2.680	17.408	3.536	19.458
Days outside prov.	0.372	4.858	0.444	3.489
Days incidental	0.625	1.037	0.754	1.120
Hunter[b]	0.179		0.300	
Total expenditures	1.912	10.594	4.472	27.297
Tax price	0.924	0.105	0.712	0.015
Alberta[b]	0.373		0.394	
Manitoba[b]	0.303		0.286	
Sample size	5,059		5,075	
Number donating	276 (5.5%)		525 (10.3%)	

[a] Computed from the subsamples of donating individuals.
[b] Dummy variables.

NSIWC is administered to subsamples of the LFS sample such that the results are representative by province of noninstitutionalized residents 15 years of age and older, including employed and unemployed individuals. Therefore, for the three prairie provinces the 1991 survey results accurately represent the wildlife-related activities of 3,422,000 residents (Filion et al.).

The survey involved self-administered, mail-back questionnaires with two follow-up reminders and in some cases, telephone follow-ups to ensure statistically valid responses. Initial samples sizes were 9,267 for Alberta; 7,523 for Saskatchewan; and 6,955 for Manitoba; and response rates of 70.9%, 74.0%, and 70.2% were achieved, respectively. Investigations of nonresponse bias suggested nonrespondents were not restricted to specific groups of individuals, nor were they located in specific geographic areas (Yiptong and DuWors). Completed questionnaires were processed under rigorous protocols which included exhaustive editing procedures to identify erroneous records and to ensure data quality, and to ensure the method matched respondent demographic data from the LFS to their NSIWC survey answers. Measures of statistical confidence were conducted such that all information used satisfies a minimum level of reliability. Further details on the survey can be found in Filion et al. and Yiptong and DuWors.

Information from 13,572 individuals was extracted from this database and a set of

Table 2. Extended

High Income		Full Sample	
Mean	SD	Mean	SD
16.42	157.21	7.838	88.516
(99.40)[a]	(376.23)[a]	(77.70)[a]	(268.88)[a]
6.922	0.857	4.204	2.008
4.205	1.537	3.440	1.574
7.079	2.351	6.696	3.336
0.414		0.465	
0.755		0.484	
0.784		0.511	
9.956	2.962	9.284	3.556
2.471	0.759	2.333	0.912
0.872		0.809	
0.706		0.600	
2.375	2.228	2.204	2.254
3.846	18.698	3.295	18.528
0.679	4.375	0.477	4.267
0.933	1.231	0.751	1.126
0.473		0.299	
8.521	41.362	4.543	27.574
0.576	0.020	0.757	0.154
0.446		0.399	
0.243		0.281	
	3,438		13,572
	568 (16.5%)		1,369

variables thought to influence their wildlife donations was devised (table 1) based upon previous studies (e.g., Applegate 1984; Brown, Connelly, and Decker; Manfredo and Haight; Harris, Miller, and Reese). Note that these independent variables are generally of three types: socioeconomic (income, education, etc.), attitudinal (attitude indices on wildlife preservation, interest in fishing and wildlife viewing, etc.), and participatory (participation in and expenditures spent on wildlife activities). To focus on the issue of participation in hunting and donation behavior we use a variable that indicates if a person has ever participated in hunting. This variable, described in table 1, is a reflection of recruitment to hunting activity rather than current participation. In order to compare our findings with previous studies of donation behavior (e.g., Kitchen) and to develop elasticities across various socioeconomic groups, we stratified the sample into three income groups: low, medium, and high. The low group includes those reporting personal 1991 income before taxes ranging from $0 to $9,999. Medium incomes were those that ranged from $10,000 to $29,999 and high incomes were over $30,000. In addition, the "price" of a donation was calculated as 1−marginal tax rate. For each individual in the sample their marginal tax rate was calculated based on standard deductions for the 1991 tax year.

Descriptive statistics by income stratum and for the entire sample are shown in table 2. For the full sample 10.1% of the individuals reported a donation and the average amount per individual was $7.84. However, the average amount for those reporting a donation was $77.70. Participation in donating and the amount donated increase across the income strata.

Table 3. ML Estimation of IHS Double-Hurdle Model Used to Explain Donations

	Low Income		Medium Income	
Variable	Particip.	Level	Particip.	Level
Constant	2.745	−23.310***	2.221	−23.739
	(2.504)	(6.808)	(6.240)	(15.308)
Income	−0.290	0.632	−0.050	0.822
	(0.279)	(0.737)	(0.259)	(0.646)
Education	0.038	0.489**	−0.002	0.777***
	(0.076)	(0.216)	(0.062)	(0.153)
Age	0.002	0.170*	−0.017	0.288***
	(0.030)	(0.095)	(0.030)	(0.076)
Rural	0.053	1.015	0.054	1.185***
	(0.232)	(0.628)	(0.189)	(0.440)
Male	−0.110	0.823	−0.470*	−0.065
	(0.276)	(0.758)	(0.267)	(0.598)
Head	0.223	0.760	0.257	−0.838
	(0.269)	(0.748)	(0.216)	(0.531)
Abundance	−0.018	0.280**	−0.023	0.254**
	(0.043)	(0.143)	(0.042)	(0.116)
Preserving	−0.073	0.290	−0.090	0.813*
	(0.160)	(0.511)	(0.160)	(0.424)
Some interest	−0.307	2.628*	−0.780**	1.655*
	(0.419)	(1.567)	(0.316)	(0.994)
Fishing interest	0.449*	−1.535*	0.109	−1.735***
	(0.254)	(0.712)	(0.190)	(0.540)
Days residence	0.136**	−0.002	0.108**	0.106
	(0.063)	(0.143)	(0.047)	(0.099)
Days in province	0.147	0.004	0.293**	0.011
	(0.092)	(0.009)	(0.150)	(0.007)
Days outside prov.	−0.289	0.145*	− 0.352**	0.061*
	(0.257)	(0.076)	(0.150)	(0.036)
Days incidental	−0.018	0.549**	0.182*	0.273
	(0.111)	(0.235)	(0.108)	(0.170)
Hunter	0.087	0.970	0.694**	1.897***
	(0.303)	(0.728)	(0.316)	(0.533)
Total expenditures	3.601***	0.041***	4.682***	0.014***
	(1.274)	(0.012)	(1.157)	(0.004)
Tax price	−1.801	4.989	−2.052	4.667
	(1.952)	(5.295)	(9.971)	(24.026)
Alberta	−0.021	−1.693**	0.460**	−2.434***
	(0.280)	(0.749)	(0.218)	(0.539)
Manitoba	−0.011	−1.393*	−0.093	−0.619
	(0.289)	(0.784)	(0.247)	(0.606)
σ		7.439***		7.128***
		(0.620)		(0.411)
σ_{12}		−5.870***		−5.877***
		(1.121)		(0.630)
θ		0.168***		0.200***
		(0.030)		(0.020)
Log-likelihood		−1,540.059		−2,739.790

Notes: Dependent variable was divided by 10 in estimation. Asymptotic standard errors in parentheses. One, two, and three asterisks denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3. Extended

High Income		Full Sample	
Particip.	Level	Particip.	Level
−0.798	−15.959	2.558***	−30.972***
(9.085)	(49.570)	(0.864)	(3.418)
−0.146	1.593**	−0.167***	1.175***
(0.118)	(0.674)	(0.056)	(0.206)
−0.020	0.590**	0.001	0.651***
(0.050)	(0.270)	(0.031)	(0.115)
−0.009	0.352*	−0.015	0.291***
(0.032)	(0.184)	(0.016)	(0.060)
0.097	0.402	0.114	0.821**
(0.145)	(0.796)	(0.096)	(0.334)
−0.067	−0.816	−0.172	0.042
(0.237)	(1.419)	(0.124)	(0.467)
0.270	−1.354	0.098	−0.306
(0.207)	(1.259)	(0.113)	(0.428)
−0.013	0.321	−0.023	0.332***
(0.042)	(0.237)	(0.022)	(0.089)
0.199	0.757	−0.064	0.949***
(0.151)	(0.844)	(0.081)	(0.320)
−0.041	3.714	−0.419**	2.649***
(0.457)	(3.069)	(0.190)	(0.929)
0.364*	−4.366***	0.150	−1.785***
(0.200)	(1.445)	(0.100)	(0.430)
0.031	0.367*	0.023	0.258***
(0.035)	(0.200)	(0.024)	(0.081)
−0.004	0.030**	0.091**	0.011**
(0.003)	(0.014)	(0.041)	(0.005)
0.041*	−0.075	0.109	0.014
(0.023)	(0.049)	(0.117)	(0.022)
0.146**	−0.689**	0.062	0.165
(0.073)	(0.315)	(0.044)	(0.127)
−0.109	2.222**	0.088	1.776***
(0.199)	(1.114)	(0.122)	(0.404)
0.178***	0.009**	1.736***	0.018***
(0.040)	(0.004)	(0.377)	(0.003)
1.621	−12.559	−1.150	8.356***
(15.017)	(81.428)	(0.737)	(2.791)
−0.149	0.082	0.154	−1.854***
(0.543)	(2.918)	(0.110)	(0.400)
−0.159	−0.047	−0.086	−0.793*
(0.247)	(1.415)	(0.116)	(0.416)
	8.042***		8.504***
	(0.632)		(0.315)
	−5.407***		−6.623***
	(0.941)		(0.466)
	0.168***		0.171***
	(0.018)		(0.012)
	−2,946.693		−7,285.011

Table 4. Elasticities with Respect to Continuous Variables Used to Explain Donations

Variable	Low Income			Medium Income		
	Prob.	Cond. Level	Uncond. Level	Prob.	Cond. Level	Uncond. Level
Income	0.325	0.087	0.412	0.799	0.308	1.107
	(0.382)	(0.103)	(0.485)	(0.635)	(0.244)	(0.878)
Education	0.343**	0.093**	0.436**	0.590***	0.227***	0.818***
	(0.152)	(0.041)	(0.193)	(0.115)	(0.045)	(0.158)
Age	0.250*	0.068*	0.318*	0.445***	0.171***	0.616***
	(0.139)	(0.038)	(0.176)	(0.118)	(0.046)	(0.163)
Abundance	0.597*	0.161**	0.758**	0.519**	0.200**	0.718**
	(0.307)	(0.081)	(0.387)	(0.240)	(0.092)	(0.332)
Preserving	0.157	0.042	0.199	0.418*	0.161*	0.579*
	(0.277)	(0.074)	(0.351)	(0.218)	(0.083)	(0.300)
Days residence	−0.001	0.000	−0.001	0.052	0.020	0.072
	(0.071)	(0.019)	(0.090)	(0.049)	(0.019)	(0.068)
Days in province	0.002	0.001	0.003	0.009	0.003	0.012
	(0.006)	(0.003)	(0.007)	(0.005)	(0.002)	(0.007)
Days outside prov.	0.013*	0.003*	0.017*	0.006*	0.002*	0.008*
	(0.007)	(0.002)	(0.009)	(0.003)	(0.001)	(0.005)
Days incidental	0.084**	0.023**	0.106**	0.045	0.017	0.062
	(0.036)	(0.010)	(0.045)	(0.028)	(0.011)	(0.039)
Total exp.	0.019***	0.010	0.030	0.014***	0.005***	0.019***
	(0.006)	(0.042)	(0.043)	(0.004)	(0.002)	(0.006)
Tax price	1.123	0.302	1.425	0.726	0.279	1.005
	(1.205)	(0.325)	(1.529)	(3.730)	(1.436)	(5.166)

Notes: Asymptotic standard errors in parentheses. One, two, and three asterisks denote significance at the 10%, 5%, and 1% levels, respectively.

Results of Estimation

Parameter Estimates

We estimate the dependent IHS double-hurdle model for the full sample and the three income strata separately. The full sets of parameter estimates are presented in table 3. The IHS parameter (θ) is significantly different from zero for all strata, suggesting that the standard (untransformed) double-hurdle model would be misspecified. The covariance parameter (σ_{12}) is significant for all strata at the 0.01 level of significance, justifying dependence between the participation and level decisions.

For the low-income stratum participation is significantly affected only by interest in fishing, involvement in residential wildlife activity, and total expenditures. In contrast, the level of donations for this stratum is affected by education level, age, attitudes regarding abundant wildlife, interest in wildlife viewing and fishing, days spent outside province, *Days incidental,* and *Total expenditures.* Only *Total expenditures* affect both the participation and level of donation, while *Fishing interest* has significant and conflicting effects on participation and level. The paucity of explanatory variables in either of the hurdles for the low-income group probably mirrors their low involvement in donation activity (table 2).

Table 4. Extended

High Income			Full Sample		
Prob.	Cond. Level	Uncond. Level	Prob.	Cond. Level	Uncond. Level
0.145***	0.872**	2.017***	0.965***	0.356***	1.320***
(0.436)	(0.345)	(0.744)	(0.167)	(0.062)	(0.227)
0.317***	0.246***	0.563***	0.437***	0.161***	0.598***
(0.103)	(0.081)	(0.180)	(0.076)	(0.028)	(0.104)
0.327***	0.254***	0.581***	0.380***	0.140***	0.520***
(0.119)	(0.092)	(0.208)	(0.078)	(0.029)	(0.107)
0.399*	0.309**	0.708*	0.601***	0.222***	0.823***
(0.215)	(0.157)	(0.369)	(0.162)	(0.059)	(0.220)
0.466**	0.375**	0.840**	0.432***	0.159***	0.592***
(0.218)	(0.153)	(0.346)	(0.145)	(0.053)	(0.198)
0.153***	0.121***	0.274***	0.111***	0.041***	0.152***
(0.044)	(0.034)	(0.074)	(0.034)	(0.013)	(0.047)
0.010	0.007	0.017	0.007**	0.003**	0.010**
(0.007)	(0.005)	(0.012)	(0.003)	(0.001)	(0.004)
0.004	0.004	0.008	0.001	0.000	0.002
(0.008)	(0.006)	(0.012)	(0.002)	(0.001)	(0.003)
−0.035	−0.024	−0.059	0.024	0.009	0.033
(0.033)	(0.021)	(0.045)	(0.019)	(0.007)	(0.026)
0.631***	0.527***	1.158***	0.016***	0.008	0.024**
(0.190)	(0.195)	(0.084)	(0.003)	(0.011)	(0.011)
−0.640	−0.479	−1.119	1.234***	0.455***	1.689***
(4.235)	(3.212)	(7.441)	(0.410)	(0.151)	(0.560)

For the medium- and high-income strata, however, more variables become significant in both of the donation decisions. Interestingly, males are more likely to participate than females among the medium-income individuals. None of the socioeconomic variables are significant in the participation equation for the high-income stratum. For the level of donation, *Education, Age,* and residence in a *Rural* area affect those in the medium-income stratum. In the high-income stratum, *Income, Education,* and *Age* affect the level of donation. Of the attitudinal variables, having *Some interest* in wildlife activity influences participation in the medium-income stratum. All attitudinal variables affect the level of donation in this stratum. For the high-income earners, the only attitudinal variable affecting donations is interest in fishing. Almost all of the involvement variables affect donation participation for the medium-income earners. Only the variables *Hunter, Days Outside Province,* and *Total Expenditures* affect the level of donation. For the high-income stratum three variables affect participation and five affect the level of donation. Note that *Hunter* positively affects participation and level in the medium stratum and only the level in the high-income stratum.

It is noteworthy that *Tax Price* does not play a significant role in either participation or level decision across the three income groups. This may be the result of the small range in variation of this variable within a stratum. However, this is not the case for the full-sample model, where *Tax Price* is significant in the level decision (table 3). The full-sample result also suggests that income is important and has opposite effects on

Table 5. Effects of Binary Variables Used to Explain Donations

	Low Income			Medium Income		
		Level ($)			Level ($)	
Variable	Prob.	Cond.	Uncond.	Prob.	Cond.	Uncond.
Hunter	0.022	2.91	1.27	0.065*	9.18*	5.19*
Fishing interest	−0.033*	−4.44*	−1.87*	−0.058*	−8.16*	−4.50*
Some interest	0.050*	7.04	2.65*	0.050*	7.09*	3.58*
Rural	0.022	2.93	1.22	0.039*	5.48*	2.97*
Male	0.018	2.42	1.04	−0.002	−0.30	−0.16
Head	0.017	2.23	0.96	−0.028	−3.87	−2.10
Alberta	−0.038*	5.01*	−2.17*	−0.078*	−11.08*	−5.94*
Manitoba	−0.032*	−4.19*	−1.85*	−0.023	−3.18	−1.89

Asterisks indicate corresponding "elasticities" are significant at the 10% level or lower.

participation and level of donation. There is also a negative influence associated with residing either in Alberta or Manitoba (relative to Saskatchewan).

Examining the Effects of Variables

An analysis of the individual effects of variables is presented in table 4. *Income,* for example, has significant and positive effects on the probability, conditional level, and unconditional level of donation for individuals in the high-income stratum. A 1% increase in income increases the probability of donation by about 1.15% and, conditional on donation, increases the level of donation by 0.87%. Consequently, the elasticity of the unconditional level is high, with a 1% increase in income leading to a 2.02% increase in donation. For all strata, the effects of education level, age, and attitudes toward the *Abundance* of wildlife on both probability and conditional level (and therefore the unconditional level) of donation are positive and significant. These elasticities, however, are low. *Total expenditures* also affect the probability and most of the levels of donation across strata as well. Elasticities for donations from low-income earners are affected by *Days outside province* and *Days incidental.* Medium- and high-income earners are affected by attitudes towards *Preserving* wildlife and *Days residence.*

For the full sample, the income elasticities of all three components (probability and levels) of donation are significant and positive but are smaller than the corresponding elasticities in the high-income stratum. These lower elasticities are likely the result of the relative unresponsiveness to income among the low-income individuals. Elasticities for the other continuous socioeconomic and attitudinal variables, *Days residence, Days in province,* and *Total expenditures* are positive and significant.

For binary variables we assess the impact of a finite change (i.e., from zero to one) in the variable on the probability of donation, the amount of donation conditional on choosing to donate, and on the unconditional donation amount, while holding all other variables constant at their sample means. The results are presented in table 5. Interesting results from this section include the fact that hunters (i.e., those who have hunted during his/her life) are about 5% more likely to donate and contribute about $8 more than nonhunters. Across all income strata, interest in wildlife viewing has significant and

Table 5. Extended

High Income			Full Sample		
	Level ($)			Level ($)	
Prob.	Cond.	Uncond.	Prob.	Cond.	Uncond.
0.086*	11.28*	8.34*	0.053*	7.91*	4.45*
−0.146*	−21.59*	−16.17*	−0.052*	−7.78*	−4.29*
0.150*	18.00*	11.93*	0.067*	10.30*	5.07*
0.031	4.18	3.02	0.023*	3.51*	1.90*
−0.046	−6.27	−4.64	0.001	0.18	0.10
−0.022	−3.27	−2.28	−0.009	−1.30	−0.70
−0.015	−2.30	−1.57	−0.053*	−7.95*	−4.31*
−0.022	−3.23	−2.24	−0.024*	−3.62*	−2.07*

positive effects, while interest in fishing has significant and negative effects, on the probability, conditional level, and unconditional level of donation. Residence in rural areas has positive effects on donations for the medium-income strata and also the full sample. Residence in *Alberta* and *Manitoba* negatively affects donation probability for both the low- and medium-income groups. A corollary of this result, of course, is that residents in Saskatchewan are more likely to donate than residents in the other two provinces.

Simulating Changes in Wildlife Donations

We used the estimated models to simulate the impacts of equal proportional declines in three variables that affect donation behavior. We chose *Income* and *Total expenditures* because of their statistical significance in explaining donation behavior across most of the models, and *Hunter* given its performance in the full model and because participation in hunting is thought by many wildlife managers to influence donations. The scenario examined for each variable was a reduction in its mean value by 15%.[10] In order to portray the findings in a meaningful context, the results are reported for each stratum and the full sample by aggregating the results over the total population of the three provinces.

Table 6 provides the estimated level of donation per person and the aggregate donation over the population by income stratum. Declines of 15% in *Income* have large effects on donations. For the high-income group (about 25% of the sample) this income reduction reduces the probability of donating by 5.52%. Unconditional on the decision to donate, the income reduction results in individual donations declining about 27% from $17.22 to $12.55 per person in this stratum. Conditional on the decision to donate, the income reduction results in an estimated decline in the amount per person donated from $53.62 to $47.23. In aggregate terms, wildlife managers and private conservation organizations could expect reductions in donations of about $3.99 million by high-income earners given a 15% decline in income in the three provinces (table 6). Using the full-sample model, this aggregate reduction is estimated to be about $7.95 million, or a decline from about $29 million to about $21 million.

[10] A 15% change in income could be considered severe. However, we are attempting to compare changes of similar magnitude in important explanators of donation behavior.

Table 6. Estimated Changes in Donations to Wildlife Conservation in Prairie Canada Given 15% Declines in Income, Recruitment to Hunting, and Annual Expenditures on Fish and Wildlife Recreation

	Estimated Dollars Donated		Estimated Percent Change in Donation		
Income Stratum	Original Amount per Person[a]	Total Aggregate Donations	Income Decline by 15%	Hunter Recruitment Decline by 15%	Total Expenditure Decline by 15%
Low	3.889	5,057,100	NA[b]	NA	−0.7
Middle	8.126	10,288,654	NA	−8.3	−0.3
High	17.215	14,727,433	−27.1	−7.0	−17.0
Full Sample	8.574	29,340,228	−18.2	−6.9	−0.5

[a] These estimates were calculated by using the donations models with the value of the independent variables at their mean values.
[b] NA indicates that the elasticity was statistically insignificant and thus the reduction would not affect donation behavior.

Reductions in hunter recruitment and total expenditures have less impact on donations than reductions in income (table 6). Hunter declines have more impact than expenditures in the middle-income stratum, while expenditures have a greater effect than hunting participation in the high-income stratum.

Discussion and Conclusions

In this article we examine wildlife donations in a manner consistent with economic theory and use econometric methods which effectively capture the varying effects of the probability of participation and the amount. The economic literature on general donations has not used econometric methods that capture these effects. Previous studies in the wildlife management literature have used very simple models and have not generally examined donations in a theoretic economic framework. Thus our study makes a contribution to both the applied economics and resource management literatures.

Zero observations are common features of microdata. The tobit model has the undesirable parametric restrictions that limit its use in empirical investigations. Most previous studies of donation behavior were based on the tobit model. Yet donation is one area where the decisions to donate and how much to donate are most likely to be made differently. The IHS double-hurdle model we consider in this study accommodates such decision structure; it also allows for nonnormality in the error distribution.

The double-hurdle model has been used frequently in microeconometric modeling. However, the empirical results in these studies have not been fully explored because the parameter estimates alone do not reveal a complete picture of the effects of explanatory variables on the dependent variable. We explore the effects of explanatory variables by examining the probability of donating, the conditional and unconditional level of donations, and deriving the elasticities of these components with respect to the explanatory variables. Such decomposition of elasticities is particularly important when the dependent variable is transformed, the participation and level decisions are correlated, and when explanatory variables have conflicting effects on the two decisions, as is the case in the present study.

We believe our findings have some important implications for donations to private and quasi-public wildlife conservation organizations. First, in one income stratum and the full sample, income has the largest effect on donation probability and the conditional and unconditional levels (table 4). This suggests that recessions may have the most important negative impacts on wildlife donations. This is supported by the fact that total expenditures on wildlife-related activities, which are also affected by economic declines, also play an important, although smaller, role in donations.

A related finding here is the observation that *Tax prices* were generally not significant in explaining donations to wildlife conservation. Kitchen and Kitchen and Dalton found similar results in explaining Canadian donations to religious causes. This raises an intriguing question about the degree of similarity of religious and wildlife conservation motives in terms of financial support. On the other hand, this similarity may also be related to (*a*) the fact that these types of donations are focused on specific issues or targets and are not donations to some more broad-based social causes (e.g., poverty), and (*b*) limited variability in *Tax prices* within the income strata. The fact that *Tax price* is significant in the full sample suggests a direction for future research.

Second, fewer hunters would lead to fewer donations. Wildlife managers should be concerned about the impact of declines in hunting participation on public wildlife conservation funding efforts through reductions in license sales and equipment purchases. The trend toward fewer hunters may continue. The probability that an individual chooses to hunt has been shown to depend on the intensity of exposure to hunting, the age at which this exposure occurs, and the degree to which hunting is culturally rooted in the individual's social environment (e.g., Purdy, Decker, and Brown; Applegate 1977). Reductions in current participation reduce the potential for youth to be exposed and in turn lead to fewer hunters in the next generation. Thus, hunting declines will not only reduce current public wildlife conservation funds, but the decline may have an even larger impact on future private conservation donations.

Changes in participation in other types of wildlife activity may also have significant effects on donations. For example, involvement in residential wildlife activities, particularly by people in lower- and medium-income strata, was found to affect donation behavior. This activity has been generally overlooked by wildlife management agencies (Boxall and McFarlane; Shaw, Mangun, and Lyons) and encouraging greater levels of participation in these activities may increase donations. Similarly, participation in nonconsumptive activities, such as taking trips to view wildlife both inside and outside the province of residence, may increase donations. Our findings suggest this may be the case for those in the medium- and high-income groups. While the decision to participate in any of these activities may be related to the level of interest in wildlife, we assume that viewing trips and residential activity provide an opportunity to learn about wildlife and that this advanced knowledge may lead to increased donations. Fully understanding the importance of these two effects, however, is a future research question.

These results have important implications for recent efforts by governments and the private sector to increase levels of ecotourism and ecotourism business opportunities. Increased ecotourism levels may not only promote economic development, but may also serve to increase financial support for wildlife management efforts through donations.

Whether changes in nonconsumptive activities can offset declines in donations due to fewer hunters is an open question, however.

Third, a set of factors that do seem to influence donations are attitudes towards wildlife abundance and preservation and interest in being involved in wildlife-related activity. These findings generally mirror those of U.S. researchers who examine tax checkoffs (e.g., Applegate 1984; Brown, Connelly, and Decker; Manfredo and Haight; Harris, Miller, and Reese). The importance of attitudinal variables, in conjunction with the apparent significance of education (tables 3 and 4), suggests that in a climate of declining budgets and government involvement in wildlife management, education efforts directed towards wildlife attitudes and interests may significantly affect private donations.

Finally, we derived an intriguing result which suggests that residents of Saskatchewan are more likely to donate than Albertans or Manitobans. This may be related to a combination of conditions such as (*a*) unique cultural factors inherent in the history of that province; (*b*) the fact that more of Saskatchewan's population is rural than urban; and (*c*) the fact that Saskatchewan's major private wildlife organization involves both consumptive and nonconsumptive wildlife recreationists, in contrast to the similar organizations in Alberta and Manitoba.

While there are calls for the traditional focus of wildlife management agencies on consumptive users to broaden to include other types of wildlife users, this debate has generally focused on the issue of the revenue captured by the agency. Wildlife managers should realize that their efforts to influence and provide service to other types of wildlife users may also affect the revenue available to private wildlife conservation organizations. In addition, wildlife organizations that oppose hunting may wish to reconsider their opposition in light of the finding that recruitment to consumptive wildlife activities may actually be beneficial to the long-term causes of the organzation and to wildlife in general.

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