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Nonmarket Valuation under Preference
Uncertainty: Econometric Models and
Estimation

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Nonmarket Valuation under Preference Uncertainty: Econometric Models and Estimation

Abstract

This paper makes an attempt to introduce preference uncertainty into discrete choice models used in contingent valuation experiments. We develop an econometric model which may characterize the degree of the uncertainty and provide an empirical illustration of the suggested model.

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Abstract

This paper makes an attempt to introduce preference uncertainty into discrete choice models used in contingent valuation experiments. We develop an econometric model which may characterize the degree of the uncertainty and provide an empirical illustration of the suggested model. The results indicate that

1. Introduction

The microeconomic theory of household behavior is typically based on the assumption that the household knows his utility function. In the context of non-market

valuation, this means that for any change of environmental quality (say), the individual will be able to state his willingness-to-pay (WTP) exactly. Hence, given the assumption of preference certainty, a natural choice of valuation question is to simply ask for WTP. As is well-known, this *open-ended* valuation question has been surpassed in popularity by the *closed-ended* valuation question. Here, the individual is asked to respond "yes" or "no" to a suggested cost/compensation for a particular change. As has been noted by several practitioners this has several advantages, including the fact that the question seem to put less of a cognitive burden on the respondent.

This paper provides an attempt to explicitly include preference uncertainty into the closed-ended approach. We allow any individual to be uncertain about his exact WTP, and show how this leads to a simple reformulation of the models suggested in Hanemann (1984) and Cameron (1988).

The paper is outlined as follows. Section 2 briefly discuss the preference uncertainty literature. Section 3 introduces the econometric model. Section 4 provides simulation results and an empirical example, based on Kriström (1990). Section 5 has concluding remarks.

2. Preference Uncertainty

The economics literature distinguishes several different categories of uncertainty: exogenous uncertainty pertains to consumer preferences or firm technology; endogenous uncertainty results from the activities taken by interacting economic agents; policy uncertainty is associated with effects of economic policy; extrinsic uncertainty relates to factors separated from economic agents, (e.g. the literature on sunspot-equilibria). For a more detailed discussion of these categories, see Hammond (1987).

The first economist to consider stochastic preferences was Georgescu-Roegen (1936). Some scattered references in the economics literature on preference uncertainty can be found since this publication, e.g. Kreps (1979) and Schelling (1983). See Hanemann & Kriström (1995) for a review. In psychology, Thurstone (1927) was the starting point of a literature on stochastic sensation functions.

For a large variety of reasons, uncertainty about tastes is usually considered in the economics literature to be exogenous. This argument is made by Becker & Stigler (1977). They analyze four different examples which all seem inconsistent with stable preferences—addiction, habits, advertising effects and fashion "waves". The framework they use is the household production approach, in which

the household produces the commodities they finally consume via a set of production functions. For example, the household derives utility from music "appreciation", which is produced by allocating time and human capital "conducive to music appreciation". Thus, if a person's willingness to pay for a particular Bach concert increases over time, this is not due to a change of preferences, but due to a greater capacity to enjoy music stemming from the "on-the-job-training-effect" of listening to Bach concerts.

In contrast, psychologists Kahnemann & Snell (1992) reach a different conclusion. They survey the literature on prediction of future tastes and cite a large number of studies in the psychological literature that appears to contradict the stable preferences paradigm. According to Kahnemann & Snell (1992) people have difficulties in evaluating the future utility of a particular state of the world. They conclude (p.189) - "little is known about the question of how accurately people predict their future tastes, or about the more specific questions of the factors that control accuracy. Indeed, formal research on this topic is so scarce that it is difficult even to judge whether the validity of predicted utility is a problem that deserves the attention of students of decision making."

This paper takes the view that preference uncertainty can be integrated into a standard welfare theoretic model. In our model, complete knowledge of preferences drops out as a special case. The following section describes our framework.

3. The Econometric Model

Let a denote an individual's true WTP for a nonmarket resource. Let $\phi(a)$ denote the probability density function of a . The crucial assumption in this paper is that the individual does not necessarily know a with certainty. Thus, the individual may perceive that her value of the resource belongs to an interval $[a - h, a + h]$, where $h > 0$. Let y denote a random variable with cumulative density function $F(y | a, h)$. We assume that F has the following properties:

$$\begin{aligned} F &= 0 & \text{if } & y < a - h \\ F &= F_a(h) & \text{if } & a - h < y < a + h \\ F &= 1 & \text{if } & y > a + h \end{aligned}$$

It will be convenient to introduce a function $G(y)$, defined by

$$G(y) = \int_{y+h}^{\infty} 0 * \phi(a) da + \int_{y-h}^{y+h} F_a(y) * \phi(a) da + \int_{-\infty}^{y-h} 1 * \phi(a) da$$

$$= \int_{y-h}^{y+h} F_a(y) * \phi(a) da + \Phi(y-h)$$

where Φ is the c.d.f of a .

To interpret this, note first that as h goes to zero, preference uncertainty shrinks to zero. In this case, $G(y) = \Phi(a)$ and the welfare analysis proceeds along the lines suggested in Hanemann (1984) and Cameron (1988) for closed-ended valuation questions.

Further, suppose that WTP is distributed as a logistic. This popular assumption in the literature can be captured as;

$$\Pr(WTP < X) = \frac{1}{1 + \exp(-\alpha - \beta X)}$$

When we allow for preference uncertainty by assuming a uniform conditional distribution of y given a , it can be shown that

$$G(y) = \frac{1}{2\beta h} \ln \left\{ \frac{1 + \exp(\alpha + \beta(y+h))}{1 + \exp(\alpha + \beta(y-h))} \right\}$$

and it follow from L' Hopitals rule that $\lim_{h \rightarrow 0} G(y) = \frac{1}{1 + \exp(-\alpha - \beta y)}$. Note that this is a general model with the conventional logistic distribution as a special case, names $h = 0$. Figure 1 illustrate a family of distribution functions $G(y)$ with different parameter values of h , where the most steepest one corresponds the the ordinary logistic distribution with $h = 0$.

$$\frac{1}{2\beta h} \ln \left\{ \frac{1 + \exp(\alpha + \beta(y+h))}{1 + \exp(\alpha + \beta(y-h))} \right\}$$

Figure 1. A family of distributions with different h values.

When the closed-ended valuation question is used, the individual is presented with an amount A to accept or reject. Let $I_i = 1$ if individual i ($i = 1..n$) accepts

to pay A and $I_i = 0$ if the individual rejects to pay. In the preference uncertainty model, the likelihood function is the given by;

$$\text{Log}(L) = \sum_{i=1}^n \{I_i \ln[1 - G(A_i)] + (1 - I_i) \ln G(A_i)\}$$

which may be optimized with respect to parameter α, β and h .

4. An Empirical Illustration

The data used here originate from a CVM survey regarding the economic value of preserving the Swedish virgin forests (Kriström, 1990). In this paper we use only the discrete choice responses with 538 observations. The data can thus be described as (A_i, I_i) for $i = 1, 2, \dots, 538$, where A_i is a bid in SEK (one of the following values 100,400,700,1000,1500,2000,2500,3000,5000,7000) and I_i the indicator variable with a value 1 if the respondent is willing to pay A_i for preserving the forests and 0 otherwise. We are interested in estimating a central tendency measure (the median or the mean WTP) based on such a data set.

In the CVM literature, there have been some controversies regarding whether to assume a linear or loglinear specification, i.e. to use the original bid A_i or the logarithm of it $\ln(A_i)$ is the likelihood function. The advantage of the log-linear specification lies in its better fit to empirical data although not strictly consistent with utility theory (Hanemann, 1984). Since our concern here is to deal with the presence of preference uncertainty and its effects on the central measure estimates, there is no loss of generality to simply use a log-specification.

Now, assume that an individual's true WTP a_i is distributed as log-logistic, i.e. $\ln(a_i) = u + \epsilon_i$, where u is the population mean of $\ln(a_i)$ and ϵ_i a random component with zero mean and constant variance. Then, under preference certainty (i.e. $h = 0$) the probability that an individual would be willing to pay A_i can be expressed as

$$\begin{aligned} \text{prob}(\ln(a_i) \geq \ln(A_i)) &= \text{prob}\left(\epsilon'_i \geq \frac{\ln(A_i) - u}{\kappa}\right) \\ &= 1 - \Phi\left(\frac{\ln(A_i) - u}{\kappa}\right) \end{aligned}$$

where ϵ' is a standard logistic variable, $\kappa = (\sqrt{\pi}/3)b$ with b as the standard deviation of ϵ . Compared to the model above, it is readily shown that $\alpha = -u/\kappa$

and $\beta = -1/\kappa$. The probability for not to be willing to pay is simply $\Phi\left(\frac{\ln(A_i)-u}{\kappa}\right)$. Thus, the log-likelihood function corresponding to this case is

$$\text{Log}(L) = \sum_{i=1}^n \{I_i \ln[1 - \Phi(A_i)] + (1 - I_i) \ln \Phi(A_i)\}$$

The Maximum likelihood estimates based on the log-likelihood function (2) and (1) are shown in Table 1. It is seen that the size of the preference uncertainty parameter h is considerably large so that it absorbs much of the variation of the individual WTP. A comparison of the κ values indicates that the population standard deviation of the "true" WTP (the standard deviation of $\ln(a_i)$) is about 10 times as smaller than that of the perceived WTP amounts by the individual respondents.¹ This has a substantial impact on the estimated mean willingness-to-pay, because. $E(WTP) = \exp(u)\Gamma(1 - \kappa)\Gamma(1 + \kappa)$.

A straightforward calculation shows that the mean WTP based on our new model estimate is about 933 SEK. The conventional model (the simple logistic one), however, has an infinite mean WTP amount since the value $\kappa > 1$. The reason for the difference is that in the conventional log-logistic estimate, much of the variation arises from the individual's uncertainty. When this uncertainty is removed, we have "recovered" the underlying "true" variation and thus effectively reduced the mean WTP estimate.

It is also interesting to compare the median values between the two models, i.e. $\exp(6.8190) \approx 915$ SEK and $\exp(6.7987) \approx 897$ SEK, respectively, which are fairly close to each other. Thus, the mean WTP estimate based on the new model being is close to the corresponding median estimate.

Table 1. Model Estimates with preference Certainty and Uncertainty

Parameters	Preference Certainty		Preference Uncertainty	
	Estimate	Standard Error	Estimate	Standard Error
u	6.8190	0.1419	6.7987	0.8769
κ	1.4705	0.1837	0.1553	77.6
h	-	-	3.2620	0.6073

5. Concluding remarks

The simple extension provided shows some promise in capturing the variance of WTP. However, the crucial assumption is that conditional distribution of y given

¹The estimates of κ and h are strongly correlated so that the standard deviation of κ becomes large.

a is uniform. Because the correlation between β or (κ) and h is strong, it is not easy to make the separation between preference uncertainty and sampling error. If the conditional distribution is not uniform, separation is impossible (for a log-normal distribution case, see Li and Mattsson, 1995, JEEM 28). Nevertheless, the suggested approach may provide a benchmark for further analysis. Preference uncertainty does seem to be a logical and natural assumption to make in the context of non-market valuation.

6. References

