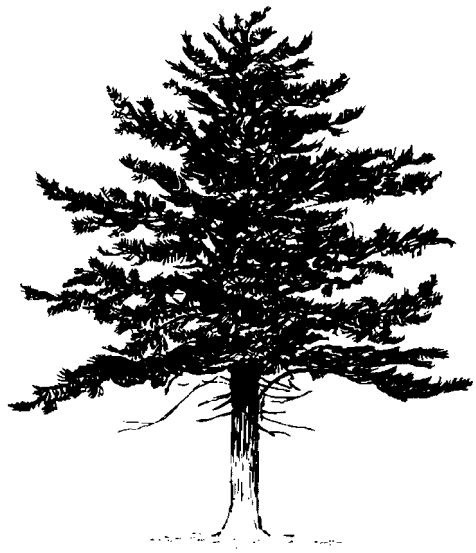
Working Paper Series in

ENVIRONMENTAL & RESOURCE ECONOMICS



Non-Market Valuation Techniques The State of the Art

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January 1999

ERE 99-01
WP 99-10

CORNELL UNIVERSITY

Non-Market Valuation Techniques: The State of the Art

by

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Non-Market Valuation Techniques: The State of the Art

Abstract:

This paper presents individual overviews of the current issues and innovations regarding the application of the following non-market valuation techniques: contingent valuation, choice experiments, travel cost method, and hedonic pricing. Each technique is described conceptually and theoretically, followed by a discussion of current research, a critique, sample applications, and suggested additional reading.

Keywords: non-market valuation, contingent valuation, choice experiments, travel cost method, hedonic pricing.

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Introduction

This report includes reviews of the state of the art of the following non-market valuation techniques: contingent valuation, choice experiments, travel cost valuation, and hedonic pricing. Other techniques, such as averting behavior, were omitted because they were determined to not be relevant to the application which motivated these reviews.

Each review consists of a description of the valuation technique, a modest introduction to the theoretical underpinnings, an account of recent research trends, a critique, example applications, and further readings. The reviews are not intended to be comprehensive literature reviews, but instead, concise, current descriptions of where the methods stand in the published literature. It is my hope that this work will serve as an introduction and a reference guide: an index to the latest work and the strengths and weaknesses of each technique.

Summary

Benefits to society are widespread and diverse: composed of both use and nonuse values. Many of the benefits are not traded in markets, hence, non-market valuation techniques are essential for estimating total value and carrying out proper cost-benefit analysis for goods like environmental quality and historic cities. Numerous non-market valuation methods are at our disposal. Each has its strengths and weaknesses.

Stated preference methods, such as contingent valuation and choice experiments, are the only methods which produce estimates of nonuse and use value. This makes them invaluable tools. Stated preference methods are preferred to revealed preference methods (e.g. travel cost and hedonic pricing) when, (1) nonuse values are of primary interest, (2) revealed preference data is unavailable and individuals are inexperienced with a proposed change in quality, and (3) the change to be valued is beyond the range revealed.

Contingent valuation has been subjected to intense scrutiny and has faired well. Theory has effectively explained behavioral differences to elicitation questions, which has lead to better survey designs and addressed many of the hypothetical bias and embedding concerns. Current research has refocused attention on the open ended question format, introduced more demand

revealing mechanisms, and found promising results from approaches which combine stated and revealed preference data.

Choice experiments present respondents with a series of choice sets, which are composed of different attribute bundles. Responses effectively isolate marginal attribute values and identify significant attributes. Behaviorally similar to contingent valuation's dichotomous choice question and the random utility travel cost method, choice experiment results are directly comparable. However, this technique avoids some of the embedding and substitution problems of contingent valuation and some of the estimation problems of travel cost. While effective at capturing the individual attribute values of a project, the total project value calculation is dubious. In addition, design decisions, such as attribute choice, are issues. Finally, the application of this method to nonuse value estimation is relatively new and untested and, like contingent valuation, choice experiment results can not be verified.

Revealed preference methods rely on respondent market activity to reveal respondent values for non-market attributes (qualities, or amenities). Hence, only users are represented and only use values are estimated. Unlike stated preference data, revealed preference data comes with an inherent sense of validity because actual market decisions generate the estimates.

The travel cost method is a useful tool for estimating recreation site demand, in particular, for long distance travelers. However, results have proven to be sensitive to assumptions, such as site choice set, preference representation, and attribute proxy. Current research has been concerned with these issues: incorporating greater flexibility into models (e.g. random parameter multinomial logit models) and evaluating the consequences of design choices. Also, as mentioned above, combined stated and revealed preference data estimation results are encouraging.

Hedonic pricing yields value estimates for resident users. However, the method suffers from its assumption of the existence of market equilibrium and produces questionable values for discrete (vs. marginal) changes in attributes. Also, like travel cost, choosing an attribute proxy that is universally understood and distinguishable is difficult. Current research has focused on site specific amenities and a multi-market approach which values attributes by considering location decisions in terms of both wage and housing markets.

The pages that follow detail each of the methods and the statements made regarding each in the preceding paragraphs. References are provided for readers who wish to pursue particular points.

Contingent Valuation (CV)

Description

CV is a non-market based direct valuation technique which asks survey participants to value changes in the good in question, making trade-offs between environmental quality and other goods. Direct methods such as CV produce stated preference data, while indirect methods such as travel cost produce revealed preference data. Direct methods are the only techniques available for capturing nonuse value, as well as use value (Cameron and Englin 1997 supply evidence that users have positive use and nonuse values, the sum of which exceeds the nonuse value of nonusers). Direct methods are preferred to indirect methods when (1) nonuse values are of primary interest, (2) revealed preference data is unavailable and individuals are inexperienced with a proposed change in quality, and (3) the change to be valued is beyond the range revealed (Huang, Haab, Whitehead 1997).

Contingent valuation values are controversial. The primary issues are embedding and the hypothetical values that are produced. Embedding refers to valuing something other than the good of interest to the surveyor, and CV's hypothetical values are dubious because real transactions are not occurring. Fortunately, specific survey questions can be utilized to divulge the degree of embedding and allow for value adjustments. However, the hypothetical nature of CV is inevitable for valuing goods that are not traded in markets, like environmental goods, and cultural and religious heritage.

Careful survey design can decrease each of these biases. In general, a credible CV study needs (1) a well defined commodity, (2) a credible payment vehicle in order to make financial commitment real, and (3) a credible implementation plan for spending participants money. Quality survey design is critical for insuring that the situation understood by the participant is that desired by the surveyor. A well designed survey and good data analysis can eliminate many potential problems, like valuing the option or alternative instead of the good, gaming in responses, poor good definition, and outliers.

In 1993, a prominent panel of economists assembled by the National Oceanic and Atmospheric Administration (NOAA) produced guidelines and "burden of proof" requirements for "legitimate" CV studies (Arrow et al. 1993). Randall (1997) discusses the primary points, providing a comment or two on CVs success with respect to each. Overall,

Randall judges the Panel's standards prohibitively expensive, citing Carson et al. (1994) as the only study that has come close to meeting all guidelines and requirements. From a variety of possible value elicitation question formats, the NOAA Panel recommended the dichotomous choice format (i.e. "yes" or "no" to paying $X). This format is easier to understand since it more closely mimics market decisions and is incentive compatible when the decision is perceived by respondents as real (Hoehn and Randall 1987). Given the plethora of studies identifying unique behavioral nuances associated with each different survey design, Randall (1997) claims that standardization is not in the future of CV, instead experimentation and a proliferation of valuation methods are (e.g. contingent ranking, contingent choice, and contingent resource compensation experiments).

Many of the early criticisms of CV are now described as theoretically justifiable behavior. Hence, respondents are behaving rationally to the available stimulus and CV itself is not inherently flawed. Even in cases where CV behavior is not consistent with theory, experimental evidence has shown that CV behavior is consistent with actual behavior (Bateman et al. 1997). Overall, this line of research has helped identify some necessary elements for creating desired survey response environments.

Theory (Fisher 1996; Smith 1997)

Let u(x,z) be individual utility, where x is a vector of market goods and z is a vector of environmental goods. The individual is not able to choose z.

The individual's problem is

$$\max u(x,z) \quad \text{s.t. } px = y$$

where p is the price vector and y is income. Demand functions for the n market goods solve this problem:

$$x_i = h_i(p,z,y), \quad i = 1, \ldots, n.$$

Hence, the indirect utility function is

$$v(p,z,y) = u[h(p,z,y),z].$$

Consider without loss of generality that z is a single environmental good. Now consider an increase in z ceteris paribus such that $z1 > z0$. Assuming the marginal utility of z is positive, we have

$$u1 = v(p,z1,y) > v(p,z0,y) = u0.$$

The willingness to pay, WTP, for this change in z is simply the compensating variation in income which makes the individual indifferent between z0 and a reduced income with z1:

$$v(p,z1,y - WTP) = v(p,z0,y) = u0.$$

Re-writing WTP explicitly in terms of Hicksian expenditure functions (i.e. the expenditures necessary to achieve the same level of utility before and after a change in an argument variable, in this case z) yields:

$$WTP = e(p,z0,u0) - e(p,z1,u0)$$
$$= y - e[p,z1,v(p,z0,y)].$$

Contingent valuation tries to elicit WTP from each individual and then aggregates these values to produce welfare estimates. Note that, in principle, the terms in this last expression are observable. This is the presumption under which indirect valuation techniques operate, assuming that a change in expenditures is due to a change in z (controlling for all other changes).

Current Research Trends

There has been a shift in practitioner perception of CV. Instead of valuing a good, respondents are viewed as valuing a plan to change the good (Carson et al. 1992, 1996). This new view acknowledges the roles of payment vehicles and implementation plans on respondent decisions.

A great deal of effort continues to be expended evaluating the reliability of CV responses. Researchers are trying to characterize the nature of willingness to pay responses and determine how best to obtain actual values with hypothetical questions. These efforts have been concentrated in two areas: using simulated markets to evaluate hypothetical bias and elicitation formats, and testing the NOAA Panel's "burden of proof" guidelines. Simulated market exercises use real money transactions to test CV survey features. Evidence of hypothetical bias has been mixed for valuation of both private (Frykblom 1997; Loomis et al. 1997; Smith and Mansfield 1996; Smith 1994) and public goods (Spencer, Swallow, and Miller 1998; Poe, Clark, and Schulze 1997; Duffield and Patterson 1992). General conclusions are a bit elusive due to the variety of elicitation formats and other design features generating results.

A. Elicitation Formats

There are numerous formats the elicitation question can take: dichotomous choice (DC; dichotomous choice comes in many forms: single-bounded, double-bounded, and multi-bounded), open ended (OE), bidding game (BG), and payment card (PC). The different formats have been shown to yield statistically different responses (Brown et al. 1996; Welsh and Poe 1998; and see the summary in Frykblom 1997). Carson (1997) points out that elicitation formats are not strategically and informationally equivalent, thus it is unreasonable to expect the same answer (Bohara et al. 1998 find support for this claim). What is important is whether the signs of answers are consistent with theory.

Until recently, dichotomous choice was the preferred format because it most closely mimicked actual market behavior decisions, receiving approval from NOAA's blue-ribbon panel of experts given that the guidelines they outlined were met (Arrow et al. 1993). Most of the debate has focused on OE versus DC (for an application comparing PC and DC see Kramer and Mercer 1997). DC has typically produced higher WTP values than OE, however it has proven difficult to establish a systematic relationship between the two formats (Bohara et al. 1998).

The difference between OE and DC values has primarily been attributed to cognitive and behavioral variations inherent in the methods (e.g. yea-saying, anchoring, uncertainty, strategizing) and statistical estimation assumptions (see Halvorsen and Sælensminde 1998 for greater detail). For example, Boyle et al. (1998) and Boyle, Johnson, and McCollum (1997) confirm previous findings of yea-saying and a systematic relationship between responses and the bid levels with the DC format. Acknowledging this problem, Langford et al. (1998) propose estimation techniques which improve parameter estimates by allowing for random bid level effects. Welsh and Poe (1998) account for uncertainty and other elicitation techniques as special cases using a multiple-bounded DC model. They find variations in decision uncertainty across question formats may be generating some of the observed differences in WTP estimates. In particular, they find a positive correlation between uncertainty and "yes" DC responses, while the OE and payment card questions are answered with a high level of certainty. While, Huang and Smith (1998) and Halvorsen and Sælensminde (1998) show that much of the difference between OE and DC may be due to error specification and functional form specification for generating WTP estimates with DC

data. Haab and McConnell (1998) also have estimation concerns, emphasizing the need for consistency between estimation and calculation, in particular bounding WTP by zero and income. A word of caution from Poe, Welsh, and Champ (1997), who show that the magnitude of the estimated differences between values produced with different question formats is sensitive to the correlation between responses when multiple responses are obtained concurrently.

Lately, OE has been experiencing a revival. In addition to the aforementioned research showing DC estimates to be statistically and design sensitive, the open ended format has been given new life from recent embedding innovations (Schulze et al. 1998; Poe, Clark, Schulze 1997) and comparison studies (Loomis et al. 1997; Balistreri et al. forthcoming). A few papers have shown OE to exhibit similar or less hypothetical bias than DC (Loomis et al. 1997; Balistreri et al. forthcoming). Loomis et al. (1997) compares OE and DC formats in both hypothetical and actual surveys for a private good and finds no justification for choosing DC over OE.

B. Hypothetical Bias

Hypothetical bias is an issue because CV values are hypothetical answers to hypothetical questions and may not equal the actual values for actual situations. Carson, Groves, and Machina (1997) provide theoretical justification for why CV estimates might exceed actual values, emphasizing the importance of incentive compatible mechanisms. Unlike private goods markets, CV does not possess market incentives for truthful preference revelation. Hence, the impression of reality in CV surveys is crucial for producing more accurate values. Cummings and Taylor (1998) illustrate the importance of whether or not payment is perceived as "real" for eliciting values closer to actual WTP. McClelland, Schulze, and Coursey (1993) find a similar result with respect to the likelihood of a loss. The "realism" theme also underlies Michael and Reiling's (1997) illustration of the importance of expectations when estimating value. Realism can be readily obtained with better survey design, utilizing focus groups, cognitive interviews, and pre-tests (for an example see Smith, Zhang, and Palmquist 1997).

Testing for hypothetical bias has typically occurred by comparing CV responses to either values extracted from revealed preference methods (Carson, Flores, Martin, and Wright

1996a; Choe, Whittington, and Lauria 1996; Brookshire et. al. 1982), or actual payments obtained from markets (Nester 1998), or experiments (Fox et al. 1998; see Spencer, Swallow, and Miller 1998 for a brief survey of the literature on all three alternatives). A surveyor could also simply ask "yes" respondents how certain they are that they would contribute (Champ et al. 1995, 1997; Ethier, Poe, Schulze forthcoming; Poe, Clark, Schulze 1997).

Dealing with hypothetical bias has come in three forms (Spencer, Swallow, and Miller 1998): (1) adjusting hypothetical answers to reflect actual values (Fox et al. 1998), (2) designing hypothetical CV surveys that produce results similar to real payments (Loomis et al. 1997), and (3) using incentive compatible contribution mechanisms to obtain "real" values (Rondeau, Schulze, and Poe forthcoming; Bjornstad, Cummings, and Osborne 1997; Fox et al. 1998; Rose et. al. 1997, Poe, Clark, and Schulze 1997; Balistreri et al. forthcoming). For the first of these, the magnitude of adjustment is derived from the hypothetical bias test results and/or theory.

As for the last, comparing hypothetical and actual values would be unnecessary if the mechanism eliciting hypothetical values is incentive compatible and demand revealing. Respectively, these requirements mean that respondents are theoretically motivated to give when their true value exceeds the cost; and, respondents do "reveal" their value in some fashion. In many of these studies, "revelation" occurs if the probability of joining is positively correlated with the true value. This is the argument underlying recent experimental efforts to test for hypothetical bias using a more demand revealing institution (Poe, Clark, and Schulze 1997; Rondeau, Schulze, and Poe forthcoming). While the dichotomous choice format has been shown to be incentive compatible, experimental economics has found that that is not enough to guarantee demand revelation—institutional structure also matters (Balistreri et al. forthcoming).

The particular institution employed by Poe, Clark, and Schulze (1997) and Rondeau, Schulze, and Poe (forthcoming) to evaluate hypothetical bias elicits contributions using a minimum cost provision point with a money back guarantee should total contributions not achieve the provision point. In addition, a rebate rule is applied should contributions exceed the provision point. Demand revelation with this mechanism (and various rebate rules) is shown in both laboratory and field applications (Rondeau, Schulze, and Poe forthcoming; Rose et al. 1997). Using the same mechanism and "actual"

data as Rose et al. (1997), Ethier, Poe, and Schulze (forthcoming) and Poe, Clark, and Schulze (1997) find mixed results for hypothetical contributions. Ethier, Poe, and Schulze find hypothetical bias in their mail and telephone surveys. However, they calibrate the DC CV values using a follow-up question which captures how certain "yes" respondents are of actually participating. Poe, Clark, and Schulze (1997) compare elicitation formats and find hypothetical bias with a dichotomous choice question, but not with an open ended question. These results are consistent with the DC formats recognized nature to produce inflated values (discussed above) and does not invalidate this method. Meanwhile, Spencer, Swallow, and Miller (1998) have applied the provision point to valuing water quality monitoring programs with a trichotomous choice question (contribute to pond A, pond B, or neither), finding no statistical difference between actual and hypothetical mean WTP values (due to large standard errors, despite large absolute differences between the mean estimates).

C. Reliability Criteria

Smith (1997) claims that today's CV researchers, having taken their lead from the NOAA "burden of proof" guidelines, have identified four essential criteria which CV results should possess in order for the estimates to be deemed reliable measures of economic value. First, CV values should be responsive to scope (NOAA Panel). Second, CV choices should pass construct validity tests, i.e. they should be sensitive to variables hypothesized to be influential (Mitchell and Carson 1989; NOAA Panel). Third, CV values should satisfy an adding-up condition, i.e. the WTP for a large single change in quality should equal the sum of WTPs for increment changes in quality which add-up to the single large change (Diamond and Hausman 1994; Diamond 1996). Lastly, CV values for objects viewed as differing in importance should differ (Kahneman and Ritov 1994).

Meeting the scope and construct validity requirements has not proven to be a problem (Ready, Berger, and Blomquist 1997; Carson 1997; Smith, Zhang, and Palmquist 1997; Alberini et al. 1997; Carson et. al. 1996b; Hanemann 1996; Smith and Osborne 1996). However, Smith (1997) criticizes the remaining points: (1) there are no guidelines for identifying an adequate scope effect, (2) the adding-up requirement is "infeasible" and "unlikely informative" because it is probably impossible to choose a quantitative representation that is similarly understood by all respondents, and (3) identifying what is

important to everyone is difficult to do and test (see Smith 1996 for an example). Furthermore, Smith and Osborne (1996) and Kopp and Smith (1997) found income and substitution effects to have important implications for WTP estimates. This finding challenges the assumptions underlying the argument for the adding-up test.

D. Combining Stated and Revealed Data

The term calibration has also oddly been applied to the combining of revealed (e.g. travel cost and hedonic pricing) and stated preference data (e.g. contingent valuation). This line of research is particularly prevalent in the current literature.

Historically, CV and the travel cost (TC) method were considered alternatives. Later they were used as a means of calibrating estimates, close estimates being a form of verification (for example see Bishop and Heberlein 1979; Sellar, Stoll, and Chavas 1985; Smith, Desvouges, and Fisher 1986; and Brookshire and Coursey 1987; Choe, Whittington, and Lauria 1996; Ready, Berger, and Blomquist 1997; for a review of studies comparing stated and revealed values see Carson, Flores, Martin, and Wright 1996a).

It was Larson (1990) and Cameron (1992) who proposed combining the two types of information from the same respondent for estimating welfare, arguing that the additional information on underlying preferences would make parameter estimates more efficient and allow for out of revealed sample prediction. Nester (1998) also cites Dickie and Gerking's (1996) paper for recognizing that adding stated preference data allows one to address problems of joint household production and simultaneity (see Nester 1998 for a brief survey of the literature). The "calibration" comes in the form of common behavioral restrictions that are applied to both data sets (for an application of this technique see Englin and Cameron 1996). This area of research appears to be very promising in particular with respect to estimating recreation demand.

Applying Cameron's (1992) suggestion and methodology, Kling (1997) assumes a behavioral model for the revealed preference data and applies the estimated parameters as restrictions to the stated preference data. Kling finds gains in bias and efficiency using simulation experiments combining TC and single- or double-bounded CV. From this artificial setting, she identifies small sample size, a small correlation between the error terms from each method, and large CV standard errors as situations when the aggregation gains are

greatest. Huang, Haab, and Whitehead (1997) suggest a test for insuring that consistent preference structures underlie both the TC and CV decision. A positive outcome to the test implies that additional bias will not be introduced by combining the data.

Another approach for combining data was proposed by Morikawa, Ben-Akiva, and McFadden (1990). In this case, a common behavior structure is assumed across data types and scale factors between the errors are estimated. Adomowicz, Louviere, and Williams (1994) apply this approach to fishing site choice.

Cameron (1992) also suggested that combined stated and revealed preference data can facilitate prediction beyond the range of the revealed data. For this purpose, behavioral structure is less important and the focus is on estimating a parameter with which to scale and validate predictions (Louviere 1996). A variation on this came from Larson, Loomis, and Chien (1983) who survey users and nonusers, modeling separate WTP functions for each group, i.e. users will be influenced by the terms of use while nonusers will not (for a more recent example, see Zhang and Smith 1996). The advantage of this approach is that it recognizes and allows for different behavior (and stated responses) from participants and non-participants.

Smith (1997) issues a few cautions with respect to combining stated and revealed preference data. First, since behavioral restrictions may be imposed between data types, it becomes increasingly important that respondents interpret CV questions as intended. Second, in contrast to ex-post revealed preference data, ex-ante responses may exhibit uncertainty (Michael and Reiling 1997 illustrate the effect expectations can have on values). Third, statistical independence assumptions are dubious in surveys asking more than one valuation question. Lastly, the approach suggested by Cameron (1992) can provide efficiency improvements only if the parametric restrictions are correct.

To account for potential correlation between multiple responses, Loomis (1997) uses a panel estimator (in particular a random effects model) which allows for modeling current recreation demand as well as changes in visits in response to changes in cost or quality. Loomis estimates per trip value as a function of quality, which lends itself to prediction. Nester (1998) also uses a panel estimator but with actual and stated preference data. This approach seems well suited for obtaining welfare estimates for site users, such as those who

use historic cities. However, results will always depend on behavioral assumptions unlike experimental approaches.

Critique

a. Hypothetical bias is a central criticism of CV. A discussion of recent research with respect to hypothetical bias and elicitation formats appears in the previous section. Trimming outliers and adjusting for a skewed error distribution are other means of reducing hypothetical bias.

   Critics argue that if CV responses are actual values then the responses should reflect basic rational economic behavior. However, CV respondents can not be forced to behave as they would in actual markets. For instance, the NOAA Panel expected that respondents were failing to consider their budget constraint and available substitutes, which would contribute to inflated values. In response, researchers added a "reminder" for the respondents. Unfortunately, the effectiveness of these studies has been ambiguous (Loomis, Gonzales-Caban, Gregory 1994; Neill 1995; Whitehead; Cummings and Taylor 1997).

   Furthermore, critics point out that the income elasticities for environmental amenities should be large if these amenities are considered luxury goods. However, Flores and Carson (1997) distinguish the income elasticity of WTP from the income elasticity of demand and show that the former is typically smaller. This discovery has important implications for benefit transfer from wealthier to poorer countries.

   Strategic bias can be a side-effect of controlling for hypothetical bias. It occurs when respondents treat the survey proposal as real and intentionally give untruthful answers in an effort to manipulate survey related policy. This bias is a concern of the open ended and payment card elicitation formats. For instance, a respondent might overstate their WTP in hopes that a proposed public good will be supplied; at which time, the respondent intends to free-ride. However, Mitchell and Carson (1989) and Hoehn and Randall (1987) have found strategic incentives lacking and strategic behavior inconsequential.

b. Embedding is the other primary criticism of CV. Embedding refers to all situations when respondents value more than the good intended to be valued. The term was coined by

Kahneman and Knetsch (1992) to describe situations when the WTP for a good valued in isolation is larger than the implied value for the same good derived from a stated WTP for a more inclusive good. Since then, the term has been used in many contexts. Primarily these are scope effects, sequencing effects, symbolic bias, whole-part bias, mental account bias, probability of provision bias, amenity mis-specification bias, and the problem of adding-up, i.e. independent valuation and summation (for a discussion and references for each of these effects, see Jakobsson and Dragun 1996).

Despite all these, CV is not necessarily at fault. The sequencing and additivity type problems are not a bi-product of CV, they occur whenever multiple goods are being valued jointly and are reasonably explained with the economic theories of substitutes and diminishing marginal utility (Carson and Mitchell 1995; Randall and Hoehn 1996). To deal with additivity, either disembedding questions are used to disentangle the specific value desired from the given value, or a menu of alternatives which vary in characteristics and costs may be offered to disclose relative values and thus the value of specific attributes. This later alternative is referred to as conjoint analysis and is a separate direct valuation technique (see my review on Choice Experiments). Dis-embedding questions elicit the proportion of the bid the respondent intended for the good of interest to the surveyor (Hanley et al. 1998; Schulze et al. 1998; Poe, Clark, Schulze 1997).

The presence of scope effects appears to be a nonissue with good survey design (Carson 1997; Ready, Berger, and Blomquist 1997). However, what constitutes an adequate scope effect is an outstanding issue (Randall 1997; Smith 1997).

c. Information bias refers to the influences the quantity of information provided has on stated values. The CV concept may be peculiar to respondents in both the elicitation question format and the goods that are commonly valued. Does respondent lack of familiarity influence values and invalidate the method? The answer appears to be "no" because there are ways to overcome these shortcomings.

Experimental economics has found that learning through practice rounds leads to more realistic responses. Bjornstad, Cummings, and Osborne (1997) show in an experimental setting using a learning design the importance of experience with the institution for obtaining more precise values. In addition, respondent unfamiliarity with

elicitation question formats was the NOAA Panel's primary motivation for advocating the dichotomous choice format. However, as the elicitation format discussion in the previous section shows, this does not appear to be a legitimate concern.

As for good unfamiliarity, Cameron and Englin (1997) show that any experience as a user as opposed to no experience has a significant positive effect on WTP and increases precision. Meanwhile, Nester (1998) found experience to have to effect. However, familiarity can easily be improved with information. More information has been found to increase WTP at a decreasing rate (Cummings and Taylor 1997; Poe, Clark, and Schulze 1997; Hanley, Splash, and Walker 1995). Information should be provided to insure that respondents understand the issue at hand and as intended by the surveyor. This amount should be determined through pretesting (Arrow et al. 1993).

d. Questionnaire design and method refers to general survey design, survey vehicle, and survey implementation. Luckily, most of these issues influencing the quality and quantity of responses have been addressed and are manageable (Dillman 1978; Mitchell and Carson 1989).

e. Non-response bias might exist if there is a systematic reason for people not to respond or refuse to participate. In this case, the sample and thus the WTP estimates may not reflect the relevant population (Whitehead, Groothuis and Blomquist 1993). Efforts to identify and correct for this bias have been mixed (Whitehead, Groothuis and Blomquist 1993; Fredman 1995). One particular form of this is payment instrument bias, where respondents take exception to the form of payment or implementation (Bateman et al. 1993). This is an issue that is easily addressed with appropriate survey design (Mitchell and Carson 1989).

f. Respondents may be behaving as "citizens," instead of "consumers" and stated WTP values may not be motivated by selfish utility maximization. If this is the case, then self-interested utility maximization is not the correct model and stated values are not compensated variations as assumed in computing welfare measures (for an overview see Blamey and Common 1992). Lazo, McClelland, and Schulze (1997) and Olof (1998) illustrate theoretically how altruism and other behavioral motives and perceptions can contribute to reported CV values.

Good citizen behavior (or altruism, moral or ethical responsibility, or low cost voting behavior) can be characterized by lexicographic preferences (i.e. an individual cannot be made better off unless there is at least the current level of the particular environmental good regardless of the levels of other goods). In this case, a theoretically differentiable utility function does not exist and it is computationally impossible to calculate welfare measures (Common, Reid, and Blamey 1997; see also Spash and Hanley 1995; Spash 1993). Hence, it is incorrect to incorporate these values into benefit-cost analysis based on rational individual preferences over alternatives. However, Common, Reid, and Blamey (1997) claim that properly designed surveys may be able to elicit "citizen" WTP. In particular, Lazo, McClelland, and Schulze (1997) point out how altruism, bequest value, and existence value can be accounted for and incorporated into benefit-cost analysis.

This discussion encompasses the "warm glow" or moral satisfaction argument for why respondents express positive WTP (Andreoni 1989, 1990; Kahneman and Knetsch 1992). Overall, the emphasis here is on the importance of recognizing individual differences and the impact these differences can have on welfare estimation. It is interesting to note that others have not found evidence of these effects (Ready, Berger, and Blomquist 1997).

On a related note, Quiggin (1998) theoretically illustrates how altruism may result in the sum of individual WTPs across the household exceeding the household WTP. Nonetheless, he concludes that, under general circumstances, household data is appropriate.

g. The NOAA Panel was also concerned about the temporal reliability of WTP values (Arrow et al. 1993), i.e. do values diminish as time passes from the original amenity change. To contend with this phenomenon the Panel suggested averaging over time. Carson et al. (1997) claim that there is no justification for the Panel's suggested "temporal averaging," arguing that they should be concerned about the sensitivity of WTP values to the sensationalism of recent events. Nonetheless, Carson et al. (1997) repeated their Exxon Valdez oil damages study two years later and found no change in values. However, they note that their initial study was carried out two years after the damaging event and may not reflect sensationalism.

h. Neo-classical economics argues that willingness to pay (WTP) to equal willingness to accept (WTA). However, estimates of WTP to avoid a loss and WTA to incur a loss are not close. Hanemann (1997) provides theoretical justification for this divergence. Carson (1997) suggests that this difference may be the norm. Some point to the Prospect Theory of Kahneman and Tversky (1979). Regardless, WTP values have been shown to be stable, while WTA values have been shown to be unstable and typically larger than WTP (Coursey, Schulze, and Hovis, 1987; Carson, Flores, and Hanemann 1995). As a result, most researchers have focused on WTP despite its recognized tendency to underestimate actual values, which is consistent with conservative estimation as encouraged by the NOAA Panel.

Example Applications

DC: Jakobsson and Dragun (1996) chp.8-9 – endangered plant and animal species; Carson et al. (1997) – damages from the Exxon Valdez oil spill; Michael and Reiling (1997) – recreation benefits with congestion; Smith, Zhang, and Palmquist (1997) – controlling marine debris; Alberini et al. (1997) - avoid recurrence of acute respiratory illness in Taiwan

OE vs. DC: Loomis et al. (1997) and Frykblom (1997) – private goods

PC Vs DC: Kramer and Mercer (1997) – U.S. value for global environmental good (tropical rain forests)

Provision point mechanism: Spencer, Swallow, and Miller (1998) – water quality monitoring with DC question; Poe, Clark, and Schulze (1997) – "green" energy program with OE and DC questions

Combined data: Nester (1998) – actual and stated data for valuing volume-based trash services; Adomowicz, Louviere, and Williams (1994) – TC and CV for fishing site choice; Ready, Berger, and Blomquist (1997) – TC and CV for Kentucky horse farms; Yaping (1998) – TC and CV for improved water quality for recreation in China

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Choice Experiment (CE)

Description

CE is a type of conjoint analysis. Conjoint analysis is a class of survey valuation techniques where respondents compare different bundles of attributes; other types of conjoint analysis include trade-off adjustment, ranking, and pair-wise ratings. Conjoint analysis has its roots in marketing, transportation, and psychology (Green and Srinivasan 1990; Batsell and Louviere 1991; Louviere 1988a, 1988b, 1991; Hensher 1994). CE, like contingent valuation (CV), is a stated preference direct valuation technique that is effective at capturing nonuse value. However, the application of CE to measuring nonuse value is extremely new (Adamowicz et al. 1998 is regarded by some as the first nonuse value study) and has yet to be carefully scrutinized (however, many of CVs concerns and resulting reliability guidelines appear to be applicable to CE).

In CE, respondents are presented with a series of well-defined choice sets (typically three choices to a set). Respondents are asked to choose the most appealing consumption bundle from each choice set. Consumption bundles have varying attributes, one of which can be price. Choices are repeated with many attribute levels and combinations. From these choices, the researcher can identify (1) the attributes which significantly influence choice, (2) an implied ranking of attributes, (3) the marginal WTP for a change in an attribute, and (4) the implied WTP for a plan which changes more than one attribute (Hanley et al. 1998; Smith 1997).

CE combines random utility theory (Thurstone 1927; Manski 1977; McFadden 1974; Ben-Akiva and Lerman 1985) with the characteristics theory of value (Lancaster 1966). The random utility framework makes CE welfare estimates directly comparable to the dichotomous choice contingent valuation approach (DC CV) and the travel cost (TC) random utility approach (Hanley, Wright, and Adamowicz 1998). Open ended contingent valuation (OE CV) is not theoretically equivalent and hence is not readily comparable to CE.

To date, much of the experience with the CE method and environmental goods relates to use value (Adamowicz, Louviere, and Williams 1994; Boxall et al. 1996). Adamowicz et al. (1998) and Hanley et al. (1998) are the only studies that I am aware of that measure nonuse (i.e. passive use) value. These authors, in addition to Smith (1997), call for more

research on non-market goods before a telling comparison to CV can be made. However, the results thus far make them optimistic.

In most cases in the literature, the CE estimates are compared to either CV or revealed preference data estimates. All the studies passed construct validity tests, i.e. the willingness to pay estimates were sensitive to variables hypothesized to be influential. Hanley, Wright, and Adamowicz (1998) and Hanley et al. (1998) found CE and DC CV values to be comparable, and CE values to be modestly larger than OE CV. This result may simply be due to the behavioral nature of the question formats. Adamowicz et al. (1998) found preferences over income to be consistent between CE and DC CV. However, the relationship between CE and DC CV values was dependent on the assumed functional form. Boxall et al. (1996) found CE values less than CV values, but contributed much of the difference to CEs aptitude for capturing substitute possibilities.

Hanley, Wright, and Adamowicz (1998) outline some topics for further research. Since CV has not performed well for benefits transfer, will CE fair better? How best should information be presented to respondents? In particular, complexity, learning, and fatigue are important issues. Finally, external validation techniques need to be developed to evaluate CE values (this is a CV issue as well).

Theory (Hanley, Wright, and Adamowicz 1998)

Consider individual n's utility function for choice i:

$$U_{in} = U(Z_{in}, S_n),$$

where Z_{in} denotes the attributes of alternative i and S_n denotes the individual's socioeconomic characteristics. If $U_{in} > U_{jn}$ then alternative i will be chosen over alternative j. Assume that U_{in} is random and only a portion of the individual's utility function is deterministic and in principle observable. Let $V(Z_{in}, S_n)$ represent this deterministic portion of utility and $\varepsilon(Z_{in}, S_n)$ represent the random and unobservable portion. Hence, we can re-write utility as

$$U_{in} = V(Z_{in}, S_n) + \varepsilon(Z_{in}, S_n).$$

Because part of utility is now unobservable, we cannot estimate utility and must estimate the probability that an individual will choose option i over others from a set of choices C:

$$\text{Prob}(i|\ C) = \text{Prob}(V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}, \text{ for all j in C}).$$

To estimate this equation, an error distribution must be assumed for the error terms. For example, the usual assumption is that the error terms are Gumbel distributed and independently and identically distributed. This implies that the probability of choosing i is:

$$\text{Prob}(i) = \exp(\mu V_{in}) / \Sigma_{j \in C} \exp(\mu V_{jn}).$$

Where μ is a scale parameter for the error variance, usually assumed to be one. This last equation is estimatable as a multi-nomial logit model once a functional form is assumed for V_{in}.

When parameter estimates have been obtained, a numerical utility level can be calculated directly for the assumed functional form. And consumer surplus, i.e. attribute values or willingness to pay, can be computed directly as the change in income necessary to offset a change in attributes and maintain the initial utility level.

Current Research Trends

See Description section.

Critique

a. CEs statistical and experimental design can be rather involved and can have many issues in common with CV (especially the dichotomous choice format). Relevant attributes must be identified and appropriate levels and ranges selected. Attribute and level descriptions must be written so as to be generally understood by respondents (Adamowicz et al. 1997 show that models based on subjective ratings of attributes can outperform models based on objective measures). Meaningful attribute bundles must be assembled. A bid (environmental good price) mechanism is needed as are bid levels. Choice sets, referred to as choice occasions, must be constructed from a sub-set of possible choices identified as sufficient for estimating parameters. Even then, the number of choice sets facing a respondent may need to be reduced to be manageable.

   Attribute design issues are particularly influential. Recall from the Theory section, that CE proposes that the value (consumer surplus) of the good is simply the sum of the attribute values. Thus, estimates of a good's value may depend on the attributes selected for inclusion in the survey during design (Hanley et al. 1998). In the literature these attributes are referred to as "main effects." Even if the "correct" attributes are included in

the design, it is possible that the sum of the attribute values does not capture the total value of the good (Hanley, Wright, and Adamowicz 1998). In these cases where the whole value is desired, CV may be preferable (Hanley et al. 1998). Smith (1997) for one challenges the assumptions necessary for aggregating in this fashion (e.g. independence across questions). Hanley, Wright, and Adamowicz (1998) agree with Smith that the treatment of attributes as independent may not be consistent with reality--attribute interactions may be important. For example, the level of one attribute may depend on the level of another.

b. CE has a few advantages over CV (Hanley et al. 1998; Hanley, Wright, and Adamowicz 1998). First, with CE it is easier to desegregate values for a good into the characteristics of the good (Willis and Garrod 1995). Valuing unique measurable attributes in conjunction with socioeconomic variables is beneficial for policy and benefit transfer applications. Second, CE avoids part-whole bias and scope concerns by allowing varying levels of the good to be included in the design. Third, CE does not experience the "yea-saying" bias found in DC CV (Adamowicz 1995). Lastly, CE is better at capturing substitute possibilities and evaluating a wider range of quality changes (Boxall et al. 1996).
c. There is no accepted means of externally validating CE results, especially in cases of large nonuse values and less-familiar choices (Hanley, Wright, Adamowicz 1998).
d. Unlike revealed preference data, which suffers from collinearity and lack of variance, CE can identify marginal attribute values by designing out these issues (Adamowicz, Louviere, and Williams 1994).
e. Like CV, CE responses are a function of the information provided (Hanley et al. 1998). This criticism refers not only to the quantity and quality of information but probably also to anchoring associated with bid levels and survey implied rankings of attributes.
f. Like DC-CV, CE estimates are sensitive to functional form (Hanley et al. 1998; Adamowicz et al. 1998).
g. A status quo bias has been detected (Adamowicz et al. 1998). In this case, respondents have a tendency to choose the status quo regardless of the alternatives. This suggests that negative utility is associated with change.

Example Applications

Adamowicz, Louviere, and Williams (1994) – use value of water flow scenarios on rivers with CE and revealed data

Boxall et al. (1996) – use value of habitat changes in moose hunting areas with CE and CV

Adamowicz et al. (1998) – nonuse value of caribou habitat enhancement program with CE and DC CV

Hanley et al. (1998) – nonuse value of environmentally sensitive areas in Scotland with CE and DC CV

Hanley, Wright, and Adamowicz (1998) – nonuse value of forest landscapes in the UK with CE and OE CV

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Travel Cost Valuation (TC)

Description

TC is a market based indirect valuation technique, which estimates a recreation site demand curve from the travel costs incurred by users of the site related good to be valued (i.e. price is travel costs, quantity is either number of visitors or number of visits, and other factors shift the demand curve). Like Hedonic Pricing, TC assumes that market prices capture changes in the good's quality. Travel costs are perceived as a lower bound to the value users have for a site. To measure the demand for a recreation site with TC, net benefits are obtained by summing up societies consumer surplus for the good. To measure the value of a change in site quality, i.e. a shift in the demand curve, the changes in consumer surplus due to the change in quality must be summed-up (using the constant utility Hicksian demand curve is theoretically appropriate here, but realistically the Marshallian demand curve is estimatable and used as an approximation). Studies have typically fallen into two categories, those based on aggregate data and those based on individual data.

With aggregate data, society is broken into groups according to distance traveled to use the good (other socio-economic variables and substitution possibilities are used to further subdivide groups into more homogeneous preference groups). Each group is then an observation relating travel costs to the number of visits per capita (or number of visitors) in a period. Note, travel costs may include the group specific time costs of traveling and being at the site in addition to a per mile factor. The demand curve and the consumer surplus is then estimatable. Net benefits is the total consumer surplus (for discussions on using zonal aggregate data see Bockstael, Hanemann and Strand 1987).

Individual data is collected with individually administered surveys and is theoretically more appealing than aggregate data (however, see Hellerstein 1995 for a Monte Carlo study showing aggregate data outperforming individual data). This type of data is appealing because it does not impose a representative profile on users and allows for subjective travel costs. Each visit is an observation with a travel cost. However, modeling the individual trade-off decision is more complicated and increasingly so when incorporating multiple sites. Collecting and including information about substitutes has proven difficult (Smith 1989). The random utility model (RUM), because of its capacity to account for multiple sites with

differing attributes, has become a popular means of predicting the probability of visiting a site. However, results are extremely sensitive to modeling assumptions which restrict an individual's substitution possibilities but gain computational simplicity (Train 1998).

There are also count models which predict the number of visits using a demand equation or demand system depending on the number of sites (see Englin, Boxall, and Watson 1998 for a recent example and Shaw and Jakus 1996 for a combined count and RUM application). These models can use either aggregate or individual data.

Theory

Simple Single Site Recreation Demand Model without Substitutes (similar to Freeman 1993):

Let U(R,X) represent an individual's preferences, where R is recreation and X is other expenditure goods. The individual's problem is the following:

$$\text{Max } U(R,X)$$

$$\text{s.t.} \quad R = qV$$
$$X = t_w W - pV$$
$$p = 2mD + c$$
$$T = t_w + 2Dt_d V + t_v V$$

where q = quality of a visit
V = number of visits
t_w = time spent working
W = wage rate
p = price of a visit
m = cost per mile (driving)
D = distance to site (in miles one-way)
c = other costs of a visit (e.g. food, lodging, entrance fees, rental fees, etc.)
T = total time available (minus sleep)
t_d = time to drive one mile
t_v = time spent at the site on a visit

The first order condition with respect to V equates the marginal benefit of a visit with the marginal costs of a visit, i.e. the travel costs:

$$q(U_R/U_X) = 2mD + c + (t_v + 2Dt_d)W$$

The marginal cost per visit, which is the right hand side of the equation, consists of variables that are obtainable through survey and other sources. If the quality of a trip is improved, the equilibrium condition predicts an increase in visits ($dV/dq > 0$).

Current Research Trends

The RUMs popularity has led to substantial research beyond the simple single trip site choice framework. The simple RUM made the unrealistic assumption of independence of irrelevant alternatives, which implies that a change in the attributes of one site has no effect on the probability of visiting the other sites. As a result, nested (Kaoru 1995; Kling and Thompson 1996; Kling and Herriges 1995), repeated choice, and sequential choice (Morey et. al. 1991; Morey et. al. 1993; Parsons 1991) models were developed which restricted substitution by imposing a decision structure. The new models produced results that were very different from those of the simple RUM (Liu 1995; Kling and Thompson 1996). Since the structure imposed by these models is still too restrictive to some, fully flexible random parameter multinomial limited dependent variable models have been developed (Chen and Cosslett 1998, Train 1998).

Within the RUM framework, choice set and site definition have a significant effect on benefit measures (Kaoru et. al. 1995; Parsons and Kealy 1992; Parsons and Needelman 1992; Feather 1994; Parsons and Hauber 1996).

Another line of research considers the effect of the timing of site use over a recreation season on welfare. Time has been represented and linked to the RUM choices in a variety of ways whose full implications have yet to be explored (Parsons and Kealy 1995; Feather, Hellerstein, and Tomasi 1995; Hausman, Leonard, and McFadden 1995; Shonkwiler and Shaw 1996).

Aggregate and individual data have been conceptually linked which allows for the calibration of the results from each source (Anderson et. al. 1988, 1992; Verboven 1996. Respectively, the links in these studies are in the simple and nested RUM settings.).

Smith (1997) advocates the validation of results using another market decision where the same non-market amenity is being traded (for example, see Vaughan et. al. 1985; and Gilbert and Smith 1985). This suggestion is not to be confused with the combining of revealed and stated preference data proposed by Cameron (1992), where the TC and contingent valuation (CV) decisions must be made by the same individual.

TC and CV data from the same respondents are being combined for improving estimation and making predictions outside the range revealed. For a discussion, see the Current Research Trends section of my Contingent Valuation review.

Critique

a. Randall (1994) points out that the true travel costs for an individual are unobtainable and hence only ordinal measures of recreation benefits from TC are possible and as such TC should "not stand alone" in measuring benefits, i.e. benchmarks or calibration should be used. Randall also makes many of the points that follow.

b. Regardless of the type of data, non-participation is an issue. TC is only able to capture use values: aggregate data is generated by users, surveys on site do not represent non-users, and surveys performed from potential user lists (e.g. recreational license holders) fail to capture the influences of the state of the resource on the level of use (Smith 1997). See Haab and McConnell (1996) and Shonkwiler and Shaw (1996) for methods for handling "zero visit" responses in individual surveys.

c. Computing travel costs for an individual (or representative individual) is somewhat arbitrary. The value of time is assumed to be the wage rate, thus failing to consider taxes and per unit leisure values not equal to the wage rate. If leisure is more valuable than the wage rate, then TC would underestimate the true values (Bowker, English, and Donovan 1996; Boxall, Adamowicz, and Tomasi 1995).

   Also, since driving is valued by the per mile cost and time, driving enjoyment or displeasure is unaccounted for. (Aside: Bateman et al. 1996 propose GIS distance measures for computing travel costs.)

d. Substitute site information has proven difficult to obtain and incorporate (see Smith 1989 for an overview and the RUM cites above and below for progress since). This point relates to the model specification point below.

e. Model specification: The method requires a great deal of prior information (or assumptions) about important elements like preferences, functional form, relevant time horizons, choice structure, etc. Hence, opening the door to substantial criticism. Mis-specification can result in bias greater than that from aggregating data (Hellerstein 1995). In particular, RUM models which assume independence of irrelevant alternatives (IIA) explicitly or implicitly (by using a nested or sequential decision model, for example see Morey, Rowe, and Watson 1993) are criticized for limiting substitution patterns, imposing constant site attribute parameters across individuals, and not providing

adequate justification for ad hoc decision structures (Chen and Cosslett 1998; Train 1998). With improved computing capacity and simulation modeling, fully flexible random parameter multinomial limited dependent variable models are possible and being evaluated (Chen and Cosslett 1998, Train 1998). Thus far, the results are mixed. Also, as mentioned, the implications of site choice set definition and guidelines for determining the appropriate choice set are being researched (Parsons and Hauber 1998; Haab and Hicks 1997). Similarly, McKean, Walsh, and Johnson (1996) consider the inclusion of complementary good prices in the model specification.

f. Aggregate data applications assume homogeneous preferences within the defined groups, i.e. representative agent (Bockstael, Hanemann, and Strand 1987).

g. Single site models assume that the destination of interest is the only or main destination. For multiple site travelers it is difficult to separate the travel cost value for one site. See Parsons and Wilson (1997) for a treatment of incidental and joint site consumption as a complementary good to the primary trip.

h. The model is time dependent in that it does not accommodate changes over time in preferences, technology, etc.

i. Difficult to a find a variable which adequately reflects the quality change of interest (Montgomery and Needelman 1997).

Example Applications

Aggregate Data: Crandall, Colby, and Rait 1992; Yaping 1998

Individual Data - RUM :

IIA or Nested: Morey, Rowe, and Watson 1993; Parsons and Kealy 1992; Caulkins, Bishop, and Bouwes 1986; Bockstael, McConnell, and Strand 1989; Hausman, Leonard, and McFadden 1995; Desvousges, Waters, Train 1996; Kaoru 1995; Montgomery and Needelman 1997

Random Parameter: Train 1998

Count Data: Englin, Boxall, and Watson 1998; Shaw and Jakus 1996

Quality Changes: Smith 1993; Kaoru 1995; Whitehead 1991; Bockstael, McConnell, and Strand 1989; Parsons and Kealy 1992; Montgomery and Needelman 1997; Choe, Whittington, and Lauria 1996; hypothetical travel cost method see Layman, Boyce, and Criddle 1996

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Hedonic Pricing (HP)

Description

HP is a market based indirect valuation technique which assumes that the equilibrium price for a market traded product is a function of the product's characteristics, including environmental quality; and, price differentials are due to differences in characteristics, which can be isolated and hence valued. The method has typically been applied with wages and property values, for example, valuing job risk and air quality.

HP assumes that equilibrium conditions exist in the traded goods market, thus the marginal price of a non-market amenity (or dis-amenity) of interest is equal to the marginal rate of substitution between the amenity and the numeraire good. The non-market marginal price comes directly from an estimated hedonic gradient function generated from the market data.

The method can be traced back to Waugh (1929). Tinbergen (1956) and Roy (1950) were the first to suggest applying the structure to labor markets and Ridker and Henning (1967) did so for air pollution valuation. Griliches (1967, 1971), Rosen (1974) and Freeman (1974) also made substantial contributions. Rosen (1979) and Roback (1982) proposed the multimarket concept.

Theory

Hedonic Property Value Approach (Brookshire et. al. 1982):

Let Q=air quality level, X=non-housing expenditures, U(Q,X) = utility, R(Q)=housing rent, and Y=X+R(Q)=income.

An individual chooses Q to maximize utility:

Max U(Q,Y-R(Q)).

From the first order condition: $R'(Q)=U_Q/U_X$ (= -dX/dQ), where R'(Q), U_Q, and U_X are respectively first derivatives of R(Q), U(Q,X) with respect to Q, and U(Q,X) with respect to X. Individuals choose where to locate on the rent-air quality gradient. We would expect $R'(Q)<0$, i.e. lower rents in more polluted areas ceteris paribus.

Wage Hedonic Approach (Viscusi 1993):

Let w=wealth, p=probability of death, U(w)=utility with wealth w, and Ud=utility of death (assume equal to 0).

Expected Utility is:

$EU = (1-p)U(w) + pUd = (1-p)U(w)$.

Note EU and p are inversely related, therefore an increase (decrease) in the risk of death could be offset by an increase (decrease) in w. Setting the total derivative equal to zero, we obtain:

$dw/dp = U(w)/[(1-p)U'(w)]$,

where U'(w) is the first derivative of U(w). This is the marginal value of risk, from which we would expect to find a premium which increases as job risk increases, this is the theoretical amount an individual would be willing to pay (accept) to avoid (accept) risk. More risk adverse individuals should require a larger premium to accept additional risk then less risk adverse individuals. The equation also says that the poor would accept risk for smaller wage increments because the marginal impact on utility is larger. It is assumed that individuals optimally position themselves along a hedonic wage-risk gradient, by maximizing their individual expected utility subject to their production function, which exhibits diminishing marginal productivity in risk. If there is an employer, wage is assumed to be a function of risk (among other things whose marginal effects are separated with econometric estimation) and the employer chooses the level of risk to maximize net revenues; while, the employee chooses the best wage-risk offer according to the same decision rule above. The gradient is all that is observable.

Multimarket Approach (Ready, Berger, and Blomquist 1997; Blomquist, Berger, and Hoehn 1988):

Let $v_k = v_k(w_k, r_k; a_k)$, where v_k is the indirect utility of a household in county k, a_k is an index of local amenities, $r_k(a_k)$ is the rental price of land in county k given a_k, and $w_k(a_k)$ is the wage in county k given a_k. An individual purchases land (q_k) and a composite good from their wage income in order to obtain a_k.

Setting the total derivative of v_k equal to zero and rearranging, the implicit price function for the amenities is: $f_k = (\partial w_k/\partial a_k) + q_k (\partial r_k/\partial a_k)$. The implicit price function is the marginal willingness to pay for an amenity change, $\partial WTP/\partial a_k$.

Since we don't observe land rents but do observe housing, replace q_k and r_k by h_k and p_k, respectively the amount and price of housing purchased: $f_k = (\partial w_k/\partial a_k) + h_k (\partial p_k/\partial a_k)$.

The signs of $(\partial w_k/\partial a_k)$ and $(\partial p_k/\partial a_k)$ are not necessarily positive and negative respectively, both differentials need to be considered (Blomquist, Berger, and Hoehn 1988). However, one might expect that locations with better amenities would have higher housing prices and lower wages due to the increased supply of workers.

Current Research Trends

The recent literature has included an abundance of studies valuing unique site-specific amenities. These include hazardous waste sites (Michaels and Smith 1990; Kolhase 1991; Kiel 1995), incinerators (Kiel and McClain 1995), hog farm odor (Palmquist, Roka and Vukina 1997), Kentucky horse farm land (Ready, Berger, and Blomquist 1997), San Francisco earthquake risk (Beron et. al. 1997), and shoreline erosion (Kriesel, Randall and Lichtkoppler 1993; van de Verg and Lent 1994; Pompe and Rinehart 1995).

Also receiving attention is joint estimation of the marginal willingness to pay for an amenity change (Ready, Berger, and Blomquist 1997; Blomquist, Berger, and Hoehn 1988). Rosen (1979) and Roback (1982) suggested that both property value and wage markets are relevant with respect to amenity change, hence the effects should be estimated jointly (see the multimarket approach theory discussion in the section above). One important application has been measuring the quality of life: $QOL_i = \Sigma_j (\partial WTP/\partial a_j)a_{ji}$ for amenities j at site i. Due to the shortcomings of joint estimation (see Critique section), Smith (1997) suggests a QOL index based on Hicksian compensated variation, i.e. the difference in expenditures necessary to achieve a fixed initial level of utility before and after a change in an amenity (Diewert 1993).

Smith (1997), also in response to joint estimation, suggests that there may be other ways households adjust to disamenities and these could also be valued. For example, Clark and Kahn (1989) include regional recreational resources as sources of compensating differentials.

Critique

a. Measures only use values. Hence, all the good's value may not be captured.

b. While direct and effective at valuing marginal changes in amenity levels, the technique cannot value discrete changes because it is unable to distinguish individual preferences, i.e. the concavity of preferences. Two individuals who choose to locate at the same place may not have the same value for an amenity change, but the method has no way of recognizing this. Hence, for large changes in the characteristic valued, individuals may have vastly different values, yet the hedonic method will only produce the one marginal value. Non-marginal changes may shift the equilibrium hedonic price function. Exact welfare measurement of discrete changes requires estimation of an environmental quality bid function as well as predicting the change in the hedonic price function (Palmquist 1991, Bartik 1987, Epple 1987). HP can only measure welfare for externalities that effect the market equilibrium (Palmquist 1992).

c. Amenities to be valued commonly must be proxied and the proxies may not represent the amenity for all individuals the way the researcher intended.

d. Of course there are estimation issues such as functional form (Cropper, Deck, McConnell 1988) and multicollinearity and outliers (Belsely, Kuh, and Welsh 1980; Gilley and Pace 1995). Belsely, Kuh, and Welsh have developed a procedure for selecting collinear variables, while Gilley and Pace suggest a Bayesian estimator which uses prior submarket information to construct bounds and produce more efficient estimates and better out-of-sample forecasts.

e. On a positive note, HP is, for the most part, free of assumptions about preferences (Rosen 1974).

f. However, noone has been able to estimate the WTP function as a second stage model from the hedonic price function (Smith 1997). All original attempts run into identification problems. In addition, the data is inadequate for linking marginal WTP to the socio-economic characteristics of home buyers.

g. There are a few problems with the multimarket approach (Smith 1997). First, location and job are assumed to change simultaneously which is not always the case (Graves and Waldman 1991). Second, housing and wage data need to be comparable across

geographic regions; however, submarkets may prevent such comparisons since the submarkets will be determining the value of amenities and not the assumed larger market. Lastly, these models are more difficult to estimate.

h. Embedding may also be problem. For example, property values may overestimate WTP for a amenity change at a single site when there are multiple sites influencing property value in the area. Likewise, high moving costs may preclude moving though property values do not, hence property values understate WTP (Schulze et. al. 1995).
i. In the case of risk, WTP to reduce risk is not equal to WTA to increase risk (see the article "Prospect Theory" by Kahneman and Tversky, 1979). Also, individuals tend to overweight low probabilities, which leads to an overvaluing of expected losses (Viscusi's 1993 summary of the value of life research reports that individuals overestimate low probabilities and underestimate high probabilities).

Some Results:

a. Values depend on distance from amenity source (Palmquist, Roka, and Vukina 1997).
b. The existing level of the amenity influences the values for a change in the amenity (Palmquist, Roka, and Vukina 1997).
c. Smith and Huang (1993,1995) confirmed a significant negative relationship between air pollution and property values.
d. Schulze et. al.'s (1995) study of Superfund sites found that the public distrusted scientists and believed that they underestimated risks.
e. For wage hedonic models, union status has been shown to be an important factor because union workers tend to be better informed, hence union wages have been found to statistically reflect risk levels (cite)

Example Applications

Automobile price hedonic pricing: Goodman (1983)

Food price hedonic pricing: Shi and Price (1998) – value food characteristics

Wage hedonic pricing: Viscusi (1993) – review of value of life literature

Property value hedonic pricing: Garrod and Willis (1992a, 1992b) – woodlands and countryside amenities; Palmquist, Ruka, and Vukina (1997) – hog farms; Beron et. al. (1997) – earthquake risk; Brookshire et. al. (1982), Smith and Huang (1993, 1995) – air quality.

Multimarket (Property value and Wage) hedonic pricing: Blomquist, Berger, and Hoehn (1988); Ready, Berger, Blomquist (1997) – Kentucky horse farm land

Robustness of estimates: Cropper, Deck, and McConnell (1988); Atkinson and Crocker (1987); Graves et al. (1988)

Studies with both CV and HP: Brookshire et. al. (1982), Ready, Berger, and Blomquist (1997)

Additional Reading

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