Can Nonuse Value Be Measured from Observable Behavior?

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Major pollution incidents such as the oil spill caused by the grounding of the *Exxon Valdez* have given immediacy to the notion of nonuse values, or values people hold (and are willing to pay) for improvements in environments or ecosystems that that they have little, or no, direct contact with. When the scope of benefit-cost evaluation is expanded (quite rightly in at least some cases involving unique, nationally prominent resources) to encompass nonusers of an injured environment in addition to direct users, the sheer numbers of people potentially affected leads to the possibility of immense nonuse values in the aggregate. Thus the emerging study of methods for rigorous and defensible measurement of nonuse values is a crucial part of adequate benefit-cost analysis and has considerable policy significance.

The importance of this issue to current environmental policy can also be seen in the actions taken by the National Oceanic and Atmospheric Administration to discharge its responsibilities under the Oil Pollution Act of 1990, which include writing damage assessment and restoration regulations. NOAA has convened a panel, headed by Nobel laureates Kenneth Arrow and Robert Solow, to review the use of contingent valuation techniques for determining nonuse value. The reasons for this panel's existence are two-fold: there is a wide consensus that contingent valuation (or CVM) approaches offer the only possibility of measuring nonuse values, yet grave and widespread concern about the prospects for direct questioning of individuals to accurately reveal values they hold for amenities which, by definition, they have little contact with.

The concern about CVM as a research tool for nonuse value measurement occurs on at least two fronts. One is the academic literature, where leading researchers on nonmarket valuation have expressed some doubts (e.g., Bishop and Welsh; Freeman 1992), while others have been more broadly and forcefully critical of CVM in any setting (e.g., Kahneman and Knetsch; Phillips and Zeckhauser). Another is in the business community, whose attention has been riveted by the magnitude of potential liability measured in damage assessments which include nonuse value; this has also motivated sharp criticism of using CVM to measure nonuse value (e.g., Cambridge Economics).

In this paper I argue that there is an alternative to CVM for inferring peoples' nonuse values, and that given the severe reservations noted above, this other avenue of research deserves more attention. Instead of eliciting peoples' professed monetary valuations of a change in a public good directly, the alternative is to rely primarily on systems of demands for market goods and/or uses of time which depend on the public good, loosely referred to as "market behavior." The basic idea is that there may be information which can plausibly be brought to bear on the valuation problem which provides sufficient structure that the preferences recovered from the observed behavior yield a calculation of the total value of a nonmarket good change.

This is simply a variant of something that environmental economists have been doing for some time, when they have invoked weak complementarity[1] to measure the value of quality changes: this is an assumption about peoples' preferences which permits a calculation of the total value of a quality change. Its unfortunate implication in the present context is that it implies nonuse value is zero; however, once it is recognized that weak complementarity is but one of many structural assumptions that can be made about the preferences for a nonmarket good, the search for plausible alternatives begins. When such a plausible alternative (perhaps one of those discussed later in this paper) is incorporated into the quasi-expenditure function recovered while integrating back (Hausman), the total value of a quality change can be calculated from demand functions, and part of that total value will be nonuse value.

To assert the possibility of using market behavior for nonuse value, the widespread consensus that it is impossible must be addressed. After a formal description of what nonuse value is, two apparent reasons for this consensus are discussed. Some possible behavioral assumptions and their implications are then briefly discussed. In concluding, the paper identifies some potential advantages of, and obvious limitations which remain with, the measurement of nonuse value from behavior.

What is Nonuse Value, Exactly?

First articulated by Krutilla, nonuse value refers to the sense of enjoyment an individual may experience from just knowing that a special ecosystem or environment exists in a healthy state. For this type of person and public good, changes in the individual's well-being will result from changes in the character of the public good, even though the person is not engaging in any activities directly related to it. The types of public goods often used as examples are old growth rain forests, visibility in the Grand Canyon, spotted owls and their habitat, grizzly bears in Montana, and the like.

To be precise about possibilities for measuring nonuse value, it needs to be defined in a formal model of consumer choice in the presence of a non-marketed public good. The individual consumer is presumed to choose market goods in a way that minimizes the cost of utility, represented by the choice problem

$$\min_{\mathbf{x}} \mathbf{px} \quad \text{s.t.} \quad u^0 = u(\mathbf{x},z),$$

where $\mathbf{x}=(x_1,\ldots,x_n)$ is an n-vector of private (i.e., market) goods and $\mathbf{p}=(p_1,\ldots,p_n)$ is a conformable price vector. The argument z represents an exogenously-determined nonmarket good, and $u(\cdot)$ is the consumer's continuous, differentiable, quasiconcave utility function. In what follows, z will often be referred to as "quality" as a convenient shorthand, though it need not be so narrowly conceived. To maintain focus on the issue of empirical measurement, the first $n-1$ goods are part of a demand system estimated by the researcher; often n=2 in practice. Then, by making a separability assumption or by assuming weak integrability (Hanemann and Morey; LaFrance and Hanemann), all other goods are aggregated into a composite commodity $x_n \equiv y - \sum_{i=1}^{n-1} p_i x_i$ with unit price.

As a result, market (i.e., Marshallian) demand coefficients for the $n-1$ goods in the demand system will be known, and the Marshallian demand coefficients for the composite commodity can be constructed from them and the budget constraint.

Substituting optimal (Hicksian) demands $\mathbf{x}^c=\mathbf{x}^c(\mathbf{p},z,u^0)$ into the objective function gives the (minimum) expenditure function $e(\mathbf{p},z,u^0)$. The solution to the dual problem

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

yields Marshallian demands $\mathbf{x}=\mathbf{x}(\mathbf{p},z,y)$ which are related to the Hicksian demands as $\mathbf{x}^c(\mathbf{p},z,u) \equiv \mathbf{x}(\mathbf{p},z,e(\mathbf{p},z,u))$. Differentiating this identity with respect to z yields the Slutsky-Hicks (S-H) equations for changes in quality:

$$\partial x_i^c/\partial z = \partial x_i/\partial z + (\partial x_i/\partial y)(\partial e/\partial z), \qquad i=1,\ldots,n\text{-}1, \text{ and}$$

(1)

$$\partial x_n^c/\partial z = (-\textstyle\sum_i p_i \partial x_i/\partial z) + (1-\textstyle\sum_i p_i \partial x_i/\partial y)(\partial e/\partial z),$$

where $\partial x_i/\partial z$ and $\partial x_i/\partial y$, $i=1,\ldots,n\text{-}1$ are coefficients estimated for the incomplete system. These equations are important to the measurement of nonuse value from demand systems, because common practices in demand system estimation and plausible restrictions on preferences introduced from outside will have the effect of "pinning down" one or more of the Hicksian quality slopes $\partial x_i^c/\partial z$. If this can be done, then it proves possible from the equations in (1) to identify the marginal valuation of the public good change, $\partial e/\partial z$, in terms of observables from the demand system coefficients.

In problems involving the valuation of quality changes, the selection of the $n-1$ private goods to include in the empirical demand system has usually been motivated by the measurement of *use* values (UV).[2] The Hicksian demands for these private goods shift as quality changes (given prices held constant), changing the areas under their demand curves above the own-price line. (Each of these areas represents the compensating variation for access to or availability of the good, *ceteris paribus*). That is, $\partial x_i^c(\mathbf{p},z,u)/\partial z \neq 0$ generally for goods which generate use value associated with the quality z.[3] These use-value generating goods must be included in the $n-1$ good empirical demand system, or there is no hope of adequately measuring use values since the relevant area between demand curves cannot be measured.

Use value can be obtained as the sum of differences in areas under the $n-1$ private good (Hicksian) demand curves corresponding to new and old levels of quality, conditioned appropriately for the sequence of price changes (e.g., Bockstael and Kling). *Nonuse value* (NUV) is the change in the expenditure function when consumption of the $n-1$ private goods is held at zero; i.e., $NUV \equiv e(\hat{p}(z_0,u),z_0,u) - e(\hat{p}(z_1,u),z_1,u)$, where the choke price vector $\hat{p}(z,u) \equiv (\hat{p}_1(z,u),\ldots,\hat{p}_{n\text{-}1}(z,u),1)$ holds the Hicksian demands for the first $n-1$ goods at zero. For simplicity in illustrating approaches, a two-good demand system will be used, with the demand for good 1 estimated econometrically and good 2 constructed from the budget constraint.

In general, the total value (TV) of a quality change from z_0 to z_1 is defined as the change in the minimum expenditure function evaluated at z_0 and z_1, and can always be separated into use and nonuse components (e.g., McConnell; Freeman 1992) as follows:

$$TV(z_0,z_1) = e(p_1,z_0,u) - e(p_1,z_1,u)$$

$$= \{e(\hat{p}_1,z_1,u) - e(p_1,z_1,u)\} - \{e(\hat{p}_1,z_0,u) - e(p_1,z_0,u)\}$$

$$+ \{e(\hat{p}_1,z_0,u) - e(\hat{p}_1,z_1,u)\}$$

$$(2) \qquad = \left\{ \int_{p_1}^{\hat{p}_1} \frac{\partial e(t,z_1,u)}{\partial t} dt - \int_{p_1}^{\hat{p}_1} \frac{\partial e(t,z_0,u)}{\partial t} dt \right\} + \int_{z_1}^{z_0} \frac{\partial e(\hat{p}_1,t,u)}{\partial t} dt$$

$$= \left\{ UV(z_0,z_1) \right\} + NUV(z_0,z_1).$$

As noted above, the use value concept extends straightforwardly to the case of multiple private goods related to quality.

Why It Might Be Possible to Use Market Behavior

The consensus that market-based methods cannot be used to measure existence value appears to be based largely on two issues: longstanding familiarity with and use of weak complementarity in valuing quality changes, and the possibility that all market goods **x** are weakly separable from the nonmarket good z in preferences. This section argues that neither is a compelling reason to abandon research on market-based methods, given the importance of nonuse value in damage assessments and the grave concern over the alternative, which is CVM.

Familiarity with Weak Complementarity

Researchers have long invoked weak complementarity as a condition on preferences to enable the measurement of the total value of a quality change. As Freeman (1979, pp. 72-73) describes succinctly, this is additional information which is imposed on the recovering of preferences that determine the constant(s) of integration. This condition, first analyzed by Mäler, implies that the total value of the quality change can be measured as the area between the (Hicksian) demand curves for the market goods **x** which are weak complements to z, because the total value is of the quality change is simply the use value. It can be incorporated into the quasi-expenditure function recovered while integrating back from the empirical demand system, as shown by Mäler and by Larson (1991).

It is important to note what this does and does not say. Assuming weak complementarity does *not* say that nonuse value cannot be measured from market demands; instead it says that when it is measured, using the quasi-expenditure function recovered from the empirical demand system under weak complementarity, nonuse value is identically zero. Likewise, *not* assuming weak complementarity says nothing about whether nonuse value can or cannot be measured from preferences recovered from market demands.

Plausibility of Weakly Separable Preferences

Perhaps the greatest concern about observation of behavior for measuring nonuse value comes from the cases where preferences are separable in the market vector **x** and the nonmarket good z. Strong separability was considered by Freeman (1979), while weak separability was analyzed by McConnell. In the extreme version of weak separability, sometimes called pure existence value, preferences take the form

$$u(\mathbf{x},z) = v[f(\mathbf{x}),z], \tag{3}$$

where $v_1 \equiv \partial v/\partial f > 0$ and $v_2 \equiv \partial v/\partial z \geq 0$. The marginal rates of substitution between all pairs of market goods are independent of z, so z is not an argument of any Marshallian demands. Thus changes in z affect utility and compensation demanded but leave no trace in behavior.

While this seems quite a devastating blow to the prospects for using market behavior for nonuse value, there are good reasons to believe that the weakly separable model (3) is inappropriate as a representation of preferences for nonmarket goods. First, it is a very restrictive specification: z is weakly separable not just from some, or many, of the goods in x, it is separable from *all* market goods. Nearly all forms of weak separability of z from elements of x do leave a behavioral trail, because if any market good is in the weakly separable group containing z, all market demands will depend on z; only one case (equation (3) above) precludes this.

A second problem with the specification (3) comes to light when it is recognized that the behavioral models which have been used for existence value are very simple, perhaps too simple to adequately capture the phenomenon of interest. In the standard consumer problem of choice subject to a money budget constraint, the notion that not all changes in value associated with changes in a nonmarket good z are reflected in monetary purchases is very believable. But a more realistic model would have the consumer maximizing utility subject to both time and money constraints; in this model, the implications of changes in consumer welfare that leave no behavioral trail are considerably harder to justify.

To see this, consider the household production model, where utility is defined over both market goods **x** and time **t** devoted to different activities. The choice problem is

(4) $$\max_{\mathbf{x},\mathbf{t}} u(\mathbf{x},\mathbf{t},z) = v[f(\mathbf{x},\mathbf{t}),z] \qquad \text{s.t } y=\mathbf{px}, \quad w=\mathbf{qt}$$

where w is the total time available and **q** is a vector of time prices conformable to **t**. The optimal demands for market goods and uses of time, $\mathbf{x} = \mathbf{x}(\mathbf{p},\mathbf{q},y,w)$ and $\mathbf{t}=\mathbf{t}(\mathbf{p},\mathbf{q},y,w)$, are independent of z because, again, pairwise marginal rates of substitution are independent of z. A discussion of how nonuse value can be defined and, in principle, measured in this model is in Larson (1992b).

But in this framework the notion of nonuse value that leaves no behavioral trail is much harder to believe: it is a change in welfare due to a change in z that leaves *both* purchases of market goods *and* allocations of time unchanged. One of the implications of pure existence value here is that the individual would not take the time to consult his or her preferences in order to respond to a CVM questionnaire, so neither CVM nor market behavior could be used for this individual. The basic question this raises is whether an individual who changes neither the allocation of market purchases nor the allocation of time in response to a change in some nonmarket parameter can meaningfully be said to have experienced a change in welfare.

A pragmatic issue concerning research strategy also arises. A fundamental judgment by the researcher is how to represent preferences, i.e., whether by the right side of (3) or the left side of (3). If preferences are written as the right side of (3), the research strategy precludes the use of observing behavior; changes in z will not show up in the Marshallian demands. Only CVM will do. If, on the other hand, the more general representation on the left side of (3) is used, the use of market methods is not ruled out *a priori*. Demands for use-related private goods can be used to calculate use value, and plausible information can be imposed on the quasi-preferences recovered by integrating back, so the NUV(z_0,z_1) term in (2) can be calculated. Since the NUV term is essentially unconstrained until some information is introduced, any value estimate which CVM is capable of generating can also be calculated using the market-based approach.

The key, though, is that with the latter strategy, *both* market and CVM approaches can be used in assessing nonuse value, which offers the prospect of useful reality checks as is now done with the calculation of use values (e.g., Cameron). The important question of what restriction on preferences should be used to calculate nonuse value from recovered quasi-preferences must be answered, but the plausibility of specific assumptions can be evaluated based on their implications for the choice process.

Potential Preference Restrictions Which Yield Market-Based Nonuse Values

Recent work has suggested some alternatives to weak complementarity as restrictions on preferences which appear plausible and which permit a calculation of nonuse value from demand systems. Two are briefly discussed here: one which does not depend on a separability assumption (weak neutrality), and one which does (implicit separability).

A good exhibits weak Hicks-neutrality, or weak neutrality, if for some price vector its Hicksian quality slope is zero; i.e., if for a price vector $\tilde{p}$, $\partial x_i(\tilde{p},z,u)/\partial z = 0$, x_i is Hicks-neutral at $\tilde{p}$ and is said to be weakly neutral to quality (Larson 1992a). This restriction can be motivated as a logical consequence of measuring nonuse value, and permits the calculation of nonuse value from the Slutsky-Hicks equations in (2). The idea is that once the researcher determines the set of $(n-1)$ goods which give rise to use value and includes them in the empirical demand system, when consumption of all these goods is held at zero, any change in the expenditure function as z changes must necessarily be nonuse value, since all the sources of use value are not being consumed. Taking $\tilde{p}$ to be the price vector that chokes off demand for all the weak complements, it must be true that $\partial x_n^c(\tilde{p},z,u)/\partial z = 0$, or else a change in z would cause a change in the composite commodity, generating a use value. This means that in the single demand equation (n=2) case, with choke price $\hat{p}_1$, the last equation in (1) can be solved for the marginal value of a quality change $\partial e/\partial z$, and nonuse value can be expressed in terms of observables (prices and the slopes of Marshallian demand function) as

$$NUV(z_0,z_1) = \int_{z_0}^{z_1} -\frac{\partial e(\hat{p}_1,t,u)}{\partial t}dt = \int_{z_0}^{z_1} \frac{-\hat{p}_1\partial x_1(\hat{p}_1,t,y)/\partial t}{(1-\hat{p}_1\partial x_1(\hat{p}_1,t,y)/\partial y)}dt.$$

This permits an analytic calculation of nonuse value for some simple functional forms, since all of the elements of the integrand are known from the demand system; for other functional forms numerical methods (e.g., Vartia) can be used. For any reference initial price p_1, use value can be calculated using the standard formulas in (2) as usual, and when added to $NUV(z_0,z_1)$ gives the total value of the quality change.

Implicit Separability

A separability assumption that is plausible in many consumer choice problems is two-stage budgeting, where expenditure is allocated first to broad commodity groups, and then among goods within commodity groups. Implicit or quasi-separability (Gorman; Deaton and Muellbauer) is a simple preference representation consistent with both stages of two-stage budgeting, and allows consistent aggregation of a composite commodity.

If the public good z is part of an implicitly separable group of market goods $x_1,\ldots,x_{n-1}$, which comprise the empirical demand system, and is not part of the group of goods n,...,q aggregated into x_n, the expenditure function can be written

$$e(\mathbf{p'},\pi_n,z,u) = \xi[f(p_1,\ldots,p_{n-1},z,u),\ g(p_n,\ldots,p_q,u),u],$$

where $\mathbf{p'} \equiv (p_1,\ldots,p_{n-1})$, $g(\cdot)$ is a price index π_n for the composite commodity x_n; and $\partial e/\partial \pi_n = x_n^c$. The Hicksian quantities for the complete system are in developing market-based methods for measuring nonuse value. However, in a real sense the task at hand is modest; given the prevailing perspectives on the subject of measuring nonuse value, demonstrating merely the possibility of using market-based methods or observation of behavior is potentially very useful.

Clearly much remains to be done in the development and application of such methods. Two constraint models seem preferable to the traditional single-constraint approach in many cases, but they are not yet very well-developed. A crucial issue is specification: the investigator must correctly identify the major sources of use value, or the goods which form an implicitly separable group with quality. However, this problem is not confined to measuring nonuse value: the standard approach of invoking weak complementarity also requires a correct and complete specification of the weak complements, or else not all use value (total value) will be picked up.

These limitations are more than balanced by several advantages of pursuing and perfecting the market-based approach. Perhaps foremost is the opportunity for contrast and comparison. It is hard to imagine a more important area for reality checks than the measurement of nonuse value. Comparisons of demand-based and CVM estimates have been used very successfully for cross-checking use values, and would be extremely valuable for nonuse values. Another is the potential for using preferences of users of an environmental facility to make inferences about nonusers with the same preference structure. For example, a trout fisherman at a pristine area such as the upper Sacramento River in California enjoys both a use and nonuse value associated with continued pristine quality of the fishery. The former derives directly from his proximity to the fishery, while the latter derives from the characteristics of the fishery apart from his use. A person with identical preferences who lives in San Diego may be priced out of the "market" for the fishery, but something can be learned about this person's nonuse values from studying the angler. That is, a combination of observing the angler's behavior and asking him questions may more precisely pin down the angler's preferences, which then can be evaluated for the San Diegan's price to assess that person's nonuse value.

In closing, this paper should be interpreted primarily as a case for plurality in measuring nonuse value. While the focus has been on using demand functions in this process, this should not be construed as an argument against direct questioning approaches. Given the social and legal importance being given to nonuse value, and the extremely limited experience we have with conceptualizing and empirically measuring it, we should be very careful not to rule out methodologies – any methodologies – prematurely.

Footnotes

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1. Weak complementarity of a public or nonmarket good with a set of market goods (e.g., Mäler; Willig) means that when the market goods are not being consumed, changes in the nonmarket good do not affect the level of utility.

2. What exactly constitutes "use" of a public good is an important issue that is not completely resolved in the literature. A substantial consensus appears to exist on basic methods of analysis, though individual treatments and definitions of goods vary somewhat depending on the issues considered (see, e.g, McConnell; Freeman 1992; Boyle and Bishop; Bishop and Welsh; and Randall). In this paper, the operational definition of a use-related private good is one whose Hicksian demand shifts with the public good.

3. Note that if this were not the case (i.e., if $\partial x_i^c(p,z,u)/\partial z$ were zero for some price level), the marginal value of the quality change could be obtained directly from the appropriate Slutsky-Hicks equation in (1).

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