Three Approaches to Defining "Existence" or "Non-Use" Value under Certainty

W. M. Hanemann

University of California, Berkeley

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA AT BERKELEY

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by

W. Michael Hanemann

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
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1. BACKGROUND

Using Freeman's notation (with a few changes), x is a vector of private market goods, p is the vector of their prices, R (a scalar) is a public good (environmental amenity) which the individual takes as given, and y is the individual's income.

> u(x,R) is the direct utility function and is increasing in R
> $x_i = h_i(p,R,y)$ i = 1,.., N are the ordinary demand functions
> v(p,R,y) is the indirect utility function, and is increasing in R
> $x_i = g_i(p,R,u)$ i = 1,.., N are the compensated demand functions
> m(p,R,u) is the expenditure function, and is decreasing in R.

[NOTE: We assume that u(.,.) is increasing in R; this does <u>not</u> imply that the ordinary demand functions, $h_i(.)$, are monotonically increasing in R, nor do we need to assume this for our analysis.]

Given an increase in quality from R' to R", utility increases from u' to u", where u'= v(p,R',y) and u"= v(p,R",y). The compensating variation for this change is C, where

$$v(p,R'',y-C) = v(p,R',y) \tag{1}$$

or

$$C = m(p,R',u') - m(p,R'',u'). \tag{2}$$

Note that, since R" > R', C > 0.

2. MALER'S WEAK COMPLEMENTARITY - ONE APPROACH TO DEFINING EXISTENCE VALUE

Adding and subtracting terms to the right-hand side of (2) yields the decomposition:

$$C = D + G \tag{3}$$

where

$$D \equiv \int_{p}^{p^*} \Sigma \; [g_i(p,R',u') - g_i(p,R'',u')] \; dp_i \tag{4}$$

and

$$G \equiv m(p^*,R',u') - m(p^*,R'',u'). \tag{5}$$

This decomposition holds for <u>any</u> price vector p*. The term D represents the sum of areas between compensated demand curves corresponding to R' and R" between the actual price p_i and the i^{th}

element of p* (this line integral is path independent). It must be emphasized that, even though R is a "good" and R" > R', D could be negative. However, the term G in (3) must be non-negative and, as noted above, C must be positive.

Maler's trick is to select a p* in such a way that G vanishes and

$$C = D. \tag{6}$$

Essentially, he does this by assuming that there exists a vector x* such that

$$\frac{\partial u(x^*,R)}{\partial R} = 0 \tag{7}$$

and then choosing the vector p* such that max[g(p*,R',u'), g(p*,R",u')] = 0. Specifically, he takes x* = 0. That is to say, he assumes that there exists a set of commodities, x_A, with the property that the marginal utility of R is zero when these commodities are not consumed. This is the Weak Complementarity assumption. Partition the vector x into $x=(x_A,x_B)$. Maler's two assumptions are :

(WC) There exists a non-empty set A such that $\frac{\partial u(0,x_B,R)}{\partial R} = 0$

and

(NE) The commodities in A are non-essential.

Whether or not weak complementarity holds is fundamentally an empirical question. What I want to question here is whether it is a useful assumption from a theoretical point of view. I don't think that it is. There are two aspects to this: (i) the measurement of C, and (ii) the definition of existence value. With regard to measurement, if weak complementarity holds, then (6) tells us that we can measure C from areas between compensated demand functions. But if there are income effects in the demand for x_A, so that the ordinary demand functions are different from the compensated demand functions, this is not going to be very useful. In a 1980 paper I showed that using the area between ordinary demand functions in that case, i.e. the quantity D' where

$$D' \equiv \int_p^{p^*} \sum_i [h_i(p,R'',y) - h_i(p,R',y)]\, dp_i ,$$

is not particularly accurate; indeed, there are some cases where D' has the opposite sign from D. Assuming that there are income effects, the requirement that one employ compensated demand functions in calculating D means that using (6) to measure C has the same information requirements as the method based on the direct application of (1).

The other issue is the use of (3) to define a measure of existence value. Suppose that weak complementarity does not hold. Then the term G is positive, rather than zero. It is tempting to call that term "existence value": it measures the benefit from the improvement in R that would accrue to the individual if she did not consume x_A. Freeman adopts this definition -- he calls it "pure non-use value" on page 15 of his paper -- and many others have also. According to this definition, then, the absence of weak complementarity is a necessary and sufficient condition for the existence of existence value (or "pure non-use value").

Obviously, a definition is merely a convention, and its usefulness is in the eye of the beholder. But I don't think that it is useful to define existence value in this way -- I don't think that G is necessarily such an interesting concept. This is demonstrated by the following example. Suppose that there are only two goods; x_1 is fishing trips (say), and x_2 is all other goods (a Hicksian composite commodity). For convenience, set $p_2 = 1$. Suppose that the ordinary demand function for fishing is given by the linear function:

$$x_1 = \alpha - \beta p_1 + \gamma y + \delta R \tag{8}$$

where α, β, γ and $\delta > 0$. With only two goods this is a valid ordinary demand function; the associated direct and indirect utility functions are given in Bockstael, Hanemann and Strand (1984, Chapter 8). In this case, however, it can be shown that:

$$D' > 0$$

$$D = 0$$

$$C = G.$$

Thus, an improvement in R raises the demand for fishing, but all of the benefit from the improvement would be classified as existence (or "pure non-use") value. In my mind, that is a major objection to defining G as existence value. [NOTE: On page 10 Freeman assumes that weak complementarity implies that a rise in R causes the ordinary demand curve to shift out to the right. It can be shown that this is true only in the vicinity of the intercept. In general, the demand curve can swivel so that part lies to the left of the old curve.]

3. THE LIMITS TO REVEALED PREFERENCE - ANOTHER APPROACH TO DEFINING NON-USE VALUE

Suppose that the true utility function is

$$u = u(x,R) = T[u\hat{}(x,R),\ R] \tag{9}$$

where T[.,.] is increasing in both arguments, and $u\hat{}(x,R)$ is a conventional utility function. Clearly u(x,R) and u^(x,R) generate exactly the same ordinary demand functions for the x's -- although they generate different compensated demand functions. The crucial feature of (9) is that the marginal rates of substitution among the x's are independent of the transformation function T[.], but the marginal rate of substitution between R and any of the x's certainly depends on T[,]. This does not arise when the utility function is simply

$$u = \hat{u}(x,R). \tag{10}$$

Thus, with (10), <u>all</u> aspects of the individual's preferences for R are captured in her ordinary demand functions for the x's. This is not so for (9): some aspects of her preferences for R are not reflected in her ordinary demand functions for any of the x's, not even indirectly.

When the utility model is given by (9), the compensating variation for the change from R' to R", C, can be decomposed into

$$C = \hat{C} + \tilde{C} \tag{11}$$

where $\hat{C}$ satisfies

$$\hat{v}(p,R'',y-\hat{C} = \hat{v}(p,R',y)$$

and $\tilde{C}$ satisfies

$$T[\hat{v}(p,R',y-\tilde{C}),R''] = T[\hat{v}(p,R',y),R'],$$

$\hat{v}$(.,.) being the indirect utility function associated with $\hat{u}$(x,R). From the assumptions on T[.,. it follows that $\tilde{C} > 0$, so that

$$C > \hat{C} > 0. \tag{12}$$

The decomposition in (11) has implications for both the measurement of C and the definition of non-use value. Obviously, it implies that C cannot be measured from observed data on the demand for the x's; only $\hat{C}$ can be retrieved. By integrating the ordinary demand functions for the x's we can recover $\hat{v}$(.) and $\hat{u}$(.), but not T[.], v(.) or u(.). This is a significant limitation on the revealed preference (travel cost) approach. An extreme example is the direct utility function

$$u(x,R) = (\Pi\ x_i^{\alpha_i}\ R^{\gamma}$$

which was used by Polinsky and Shavell and some others in the literature on property values. In that case, the ordinary demand functions are entirely independent of R, and only the term in parentheses in (13) can be recovered from them. Although R does not affect the individual's demand for any private market commodity, she still places a positive value on improvements in R; in fact, $C = \tilde{C}$.

This suggests that the quantity $C\sim$ is a good candidate for the label "non-use value." It represents that portion of the benefits which is not associated with the individual's preferences for private market commodities.

A necessary and sufficient condition for the existence of this non-use value is that, for any utility function $u(x,R)$, there exist a subfunction $u^\wedge(x)$ and an aggregator function $T[u^\wedge,R]$, with $T_R \not\equiv 0$, such that $u(x,R)$ can be represented as in (9). Conversely, the condition for $C\sim = 0$ is that

$$\frac{\partial T[.,R]}{\partial R} \equiv 0. \tag{14}$$

This is not the same as Maler's weak complementarity condition. After all, the utility function in (13) satisfies weak complementarity, but not (14); thus $G = 0$ but $C\sim > 0$. If we apply weak complementarity to $u(x,R)$ in (9), this requires that:

$$x_A = 0 \quad \rightarrow \quad \frac{\partial u^\wedge(0,x_B,R)}{\partial R} = 0 \quad \text{and} \quad \frac{\partial T[u^\wedge(0,x_B,R),R]}{\partial R} = 0.$$

But, (15) does not imply (14). Suppose, for example, that

$$u(x,R) \quad \begin{matrix} u^\wedge(x,R) & \text{if } x_A = 0 \\ T[u^\wedge(x,R),R] & \text{if } x_A > 0. \end{matrix}$$

This satisfies (15) -- weak complementarity -- but not (14). Thus, weak complementarity is not sufficient for (14), nor is it really necessary for (14): it is just a different type of condition.

By definition, the non-use value $C\sim$ cannot be measured from conventional market data unless there is a (real or simulated) market for R -- i.e. a contingent behavior or contingent valuation exercise. The alternative is to assume that $C\sim = 0$ -- i.e. to assume that the utility function has the form (10) rather than (9). This is what has been done in all travel cost studies to date (including my own); whether it is justified raises issues which I won't go into here.

4. FREEMAN'S "PURE EXISTENCE" VALUE.

First note that, for any R* intermediate between R' and R", one can always decompose C into

$$C = C \quad + C$$

where

$$C \quad \equiv m(p,R',u') - m(p,R^*,u') \tag{18}$$

and

$$C^+ \equiv m(p,R^*,u') - m(p,R'',u'). \tag{19}$$

The quantity C^- is the individual's willingness to pay for the increase from R' to R*, while C^+ is approximately -- but not exactly -- her willingness to pay for the increase from R* to R". [The exact WTP for the latter change would be $m(p,R^*,u^*) - m(p,R",u^*)$, where $u^* \equiv v(p,R^*,y)$.] Whether or not this is a useful decomposition depends on the significance that can be attached to R*.

On page 15 of his paper Freeman introduces the condition that:

(F) There exists a value R* and a commodity (group) A such that

$$R \leq R^* \rightarrow g_A(p,R,u) = 0 \text{ for all } (p,u),$$

i.e. he postulates the existence of a threshold resource level, R*, below which the compensated demand for commodity group A is zero. It can, in fact, be shown that this is equivalent to the following condition:

$$R \leq R^* \rightarrow \frac{\partial u(x,R)}{\partial x_A} = 0.$$

Thus, (F) is, in effect, the inverse of Maler's weak complementarity condition. [NOTE If one also assumes that

$$R \leq R^* \rightarrow \frac{\partial u(x,R)}{\partial R} = 0$$

then (21) essentially implies weak complementarity.]

Freeman uses the threshold value R* in (20) to define what he calls "pure existence value". This is intended to be the quantity C^- in (18), but that is not quite how it is defined. Freeman relates his concept to the choke price for the commodity group A, i.e., the price (vector) p_A^* such that

$$g_A(p_A,p_B,R,u) = 0 \quad \text{for all } p_A \geq p_A^*,$$

where p has been partitioned into $p=(p_A,p_B)$. Freeman's pure existence value, CS_E, is defined on page 17 as

$$CS_E \equiv m(p_A^*,p_B,R',u') - m(p_A^*,p_B,R^*,u').$$

On page 17 Freeman assumes that $R' < R^* = R"$, and he makes a distinction between a model where $p_A = p_A^*$ (his third model) and a model where $p_A < p_A^*$ (his fourth model). However, that distinction is nugatory. This follows from the following

LEMMA Let R* be defined as in (20). Let $p_A^* = p_A^*(p_B,R,u)$ be the choke price in (23). Then, for any $R \leq R^*$

(i) $p_A^*(p_B,R,u) = \{ p_A \quad p_A \geq 0 \}$

(ii) $m(p,R,u) = m(p_A^*,p_B,R,u) \equiv \min \Sigma\, p_B x_B \text{ st } u(0,x_B,R) = u.$

This leads to two conclusions. The first is that Freeman's "use value" in his fourth model, defined by his equation (6), is zero by virtue of (25). Operationally, there is no distinction between his third and fourth models. The statement on page (18) that

> "comparing equations (4) and (8) shows that the expression for total value where existence value is involved is not the same as the expression for total value where there is no separate existence value."

is incorrect; his equations (4) and (8) are identical. The second conclusion is that whenever $R' \leq R^*$, as Freeman assumes on pp 17-19, $CS_E \equiv C^-$.

To summarize, Freeman's concept of pure existence value corresponds to the quantity C in (18) when R^* is the threshold level in (20). Whether that is a useful concept depends on the existence of a commodity group A satisfying (20), which is entirely an empirical question.

5. WHO NEEDS DECOMPOSITIONS OF TOTAL VALUE ?

My final comment concerns Freeman's fifth model, in which he assumes that $R' < R^* < R''$ and attempts to combine his pure existence value together with his previous distinction between use and non-use values along the lines of (3) - (5) above, in order to derive a global decomposition (see p.19):

Total Value	=	Existence Value	+	Non-Use Value	+	Use Value.

While the algebra is certainly correct, I find the motivation for this decomposition to be somewhat strained. In order to make it work Freeman has to alter his previous definitions of use and non-use value so that, together, they sum to the quantity C^+ in (19). Accordingly, he now defines non-use value to be not G in (5) but instead what I will call CS_{N^*}, where

$$CS_{N^*} \equiv m(p_A^*, p_B, R^*, u') - m(p_A^*, p_B, R'', u').$$

By subtraction, use value is now not D in (4) but instead CS_{U^*}, where

$$CS_{U^*} \equiv m(p_A^*, p_B, R'', u') - m(p, R'', u').$$

[In his definition of CS_{U^*}, Freeman includes the term $m(p_A^*, p_B, R^*, u') - m(p, R^*, u')$; but, from (25), this is zero.]

In my opinion, it is a little farfetched to call (28) "use value," and the distinction between (24) -- "existence value" -- and (27) -- "non-use value" -- is rather fragile. The point is that the decomposition in (17) is a different type of decomposition from that in (3), and trying to force them into a single framework is too procrustean for my taste. Taken separately, I don't find either decomposition to be too interesting -- I prefer the decomposition in (11). Putting them together in the global framework of (26) hinders things rather than helping them.

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