Income–Time Endowments, Distributive Equity, and the Valuation of Natural Environments

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In determining the net benefits attributable to the continued availability of a unique natural environment, it is standard practice to subtract maintenance or operating cost from an estimate of aggegate benefits. Site benefits, in turn, are derived typically from the use of some variant of contingent valuation or travel–cost methodologies. In this analytic framework, users of the site can affect the efficiency evaluation of its continued availability by their willingness to forego income (in the case of compensating variation) to insure supply. The introduction of time-constrained utility maximization into the analysis presents an interesting extension of this framework; namely, it allows users to guarantee supply either by foregoing income or by foregoing leisure or by some combination of the two. This extension is interesting from both an efficiency and distributive equity point of view. On the efficiency side, the introduction of leisure–time payments tends to increase estimates for aggregate site benefits. On the distributive equity side, benefit estimates based on income–time endowments may have considerable "fairness" advantages over estimates based on income endowments alone.

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An Illustration

Suppose a utility-maximizing individual is allowed use of a unique recreation area either by paying for site services or by agreeing to do maintenance work on the site. If the area were unavailable to the user, utility would be U^0 where

$$U^0 = U(Y, T, P, t, 0) \tag{1}$$

and

Y = income;
T = leisure time;
P = a vector of relative prices;
t = a vector of time prices;

and 0 indicates the site is unavailable for use. A rational individual would be unwilling to contract for any income–leisure time payment which would result in a level of utility less than U^0. One contract consistent with this condition might be called the **money** compensating variation payment (C_y):

$$C_y = (\Delta Y_0, 0) \tag{2}$$

where

$$U(Y - \Delta Y_0, T, P, t, 1) = U^0$$

and 1 indicates the site is available for use. In this case, site supply is being insured through foregone income only. A second special case might be called the **time** compensating variation payment (C_T) defined as

$$C_T = (0, \Delta T_0) \tag{3}$$

where

$$U(Y, T - \Delta T_0, P, t, 1) = U^0.$$

Here site supply is being insured through foregone leisure only. More generally, (2)

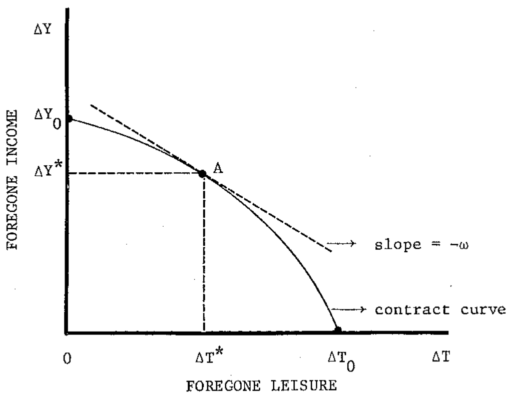

Figure 1. Income–Time Payments and Compensating Variation.

and (3) belong to a locus of income–leisure time payments for which the user would voluntarily contract to insure supply. This relationship is the willingness-to-pay locus or contract curve consisting of all (ΔY, ΔT) combinations resulting in a level of utility U^0:

$$U^0 = U(Y - \Delta Y, T - \Delta T, P, t, 1) \quad (4)$$

Along the contract curve, an individual is indifferent between making any pair of income–leisure time payments and being guaranteed access to the resource, and making no payments and being denied access.

The valuation question now becomes one of identifying the (ΔY, ΔT) combination along (4) which correctly reflects user benefits. By total differentiation of (4), the slope of the contract curve is:

$$\frac{d\Delta Y}{d\Delta T} = \frac{-\partial U/\partial \Delta T}{\partial U/\partial \Delta Y} \quad (5)$$

If marginal utility is diminishing with respect to both income and leisure time, then the willingness-to-pay locus or contract curve is concave to the origin as illustrated in Figure 1. The individual's relative valuation of leisure time is reflected in the steepness of the contract curve, that is, in the marginal rate of substitution between leisure time and income.

Given (ΔY, ΔT) payments which result in a level of utility U^0 for the user, the payment combination which maximizes the contribution to site net benefits is found by solving the following:

$$\begin{aligned} &\underset{(\Delta Y, \Delta T)}{\text{MAX}}\ \rho = \Delta Y + \omega \Delta T \\ &\text{s.t. } U = U^0 \end{aligned} \quad (6)$$

where ω is the market-determined wage rate for site maintenance work. That is, by agreeing to a (ΔY, ΔT) contract, aggregate benefits are increased by ΔY while maintenance costs are reduced by $\omega \Delta T$. A necessary condition for solving (6) is that the slope of the contract curve (5) equals the wage rate. This is illustrated in Figure 1 at point A, corresponding to payments of ΔY^* and ΔT^* and a benefit measure of $\rho^* = \Delta Y^* + \omega \Delta T^*$ attributable to the user.

Efficiency Implications

As correctly pointed out by Bockstael and Strand, money compensating variation and time compensating variation are not necessarily equal. In fact, $C_y \gtreqless C_T$ depending on the shape of the user's contract curve (i.e., depending on the marginal rate of substitution between income and leisure) and on the market-determined wage rate for maintenance services. More fundamentally, as illustrated in this simple model, neither C_y nor C_T is necessarily the correct welfare measure of user benefits. Compensating variation is uniquely determined by payments ΔY^* and ΔT^*. This corresponds to user benefits of ρ^* which is larger than either ΔY_0 or $\omega \Delta T_0$. By restricting payments to income or time only, constrained estimates of user benefits will be underestimated by $(\rho^* - \Delta Y_0)/\rho^*$ or $(\rho^* - \omega \Delta T_0)/\rho^*$ respectively.[1]

Equity Implications

It is commonplace to present efficiency recommendations with qualifications

[1] This result is analogous to option value arguments advanced by Graham, Freeman, and others concerning benefit estimation under uncertainty.

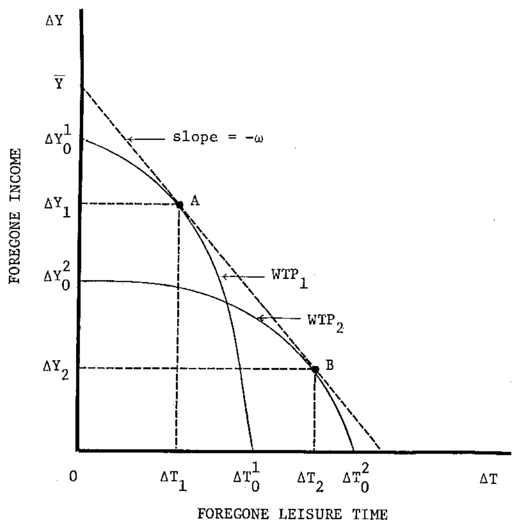

Figure 2. Income–Time Endowments and the Valuation of User Benefits.

based on distributive equity considerations. Since benefit estimates are dependent upon existing income endowments, which may or may not be equitable, advocating a resource policy solely on the basis that it constitutes a potential Pareto improvement cannot insure that an actual increase in social welfare will occur. While extending benefit estimation to allow for both income and leisure–time payments cannot eliminate equity reservations, benefit estimates based on income–time endowments may have significant equity advantages over those based solely on income endowments.

Consider Figure 2. Contract curves for two site users are illustrated by WTP_1 and WTP_2. Comparing WTP_1 and WTP_2, the former may reflect payments agreeable to a "busy executive" or "yuppie professional" who values time highly and has a high level of income, while the latter might be associated with a "struggling graduate student" or a "retiree on fixed income" who has more leisure time but restricted income. Despite differing marginal rates of substitution between leisure and income, as well as differing income–time endowments, the compensating variation measure of user benefits is identical for the two users. In the absence of an opportunity to contribute labor to insure supply, willingness-to-pay in terms of income would have been ΔY_0^1 for user one and $\Delta Y_0^2 < \Delta Y_0^1$ for user two. The extended analysis illustrates that the two users actually "value" the site equally once supply can be insured with combinations of foregone leisure and income. Additionally, by restricting payments to income, aggregate benefits attributable to the two users would be underestimated by $2\bar{Y} - (\Delta Y_0^1 + \Delta Y_0^2)$.

The use of time compensating variation estimates of benefits would suggest that type two users value the site more highly (i.e., $\Delta T_0^2 > \Delta T_0^1$) while money compensating variation measures would suggest just the opposite. These contradictory results illustrate the sensitivity of valuation procedures to the implicit judgments which are made with respect to an acceptable endowment base. While there is no indeterminancy encountered in identifying a unique measure of compensating variation given endowment assumptions, considerable ambiguity exists in selecting an equitable base.[2] While the model developed here is much too oversimplified to make any definitive statements, it does suggest that allowing users to express their valuation of a recreation site through both income and leisure–time payments may result in more realistic and equitable estimates for site benefits. Unfortunately the applicability of such a procedure may prove limited since real-world possibilities for contracting for leisure–time payments may be severely restricted.

References

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[2] For a recent discussion of the meaning of value in a benefit estimation context, see Brown. For a related discussion on aggregation and a proposed resolution of compensation conflicts, see Harberger and Ng respectively.

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